Republic of the Philippines
CIVIL AVIATION AUTHORITY OF THE PHILIPPINES

AIRCRAFT ACCIDENT INVESTIGATION AND INQUIRY BOARD

FINAL REPORT

RP-C8840
Cessna152

OPERATOR: OMNI AVIATION CORPORATION

TYPE OF OPERATION: FLIGHT TRAINING

DATE OF OCCURRENCE NOVEMBER 13, 2023

PLACE OF OCCURRENCE: BARANGAY TABING ILOG, LICAB, ZARAGOZA, NUEVA ECIJA, PHILIPPINES

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Cessna152, RP-C8840 Final Report

FOREWORD

This report was produced by the Aircraft Accident Investigation and Inquiry Board (AAIIB), Civil Aviation Authority of the Philippines, MIA Road, Pasay City, Philippines.

The report is based upon the investigation carried out by the AAIIB in accordance with Annex 13 to the Convention on International Civil Aviation, Republic Act 9497 Section 42, and Philippine Civil Aviation Regulation Part 13.

Readers are advised that the AAIIB investigates for the sole purpose of enhancing aviation safety. Consequently, AAIIB reports are confined to matters of safety significance and may be misleading if used for any other purpose. It should be noted that the information in AAIIB reports and recommendations is provided to promote aviation safety, and in no case is it intended to imply blame or liability.

Furthermore, no part of the AAIIB report or reports relating to any accident or investigation shall be admitted as evidence or used in any suit or action for damages arising out of any matter mentioned in such report or reports.

FINAL REPORT

TITLE: Accident involving a Cessna 152 type of aircraft with Registry Number RP-C8840 that experience forced landing following a total loss of power at Brgy. Tabing Ilog, Licab, Zaragoza, Nueva Ecija, Philippines, on November 13, 2023/0730H local time.

Notification of Occurrence to National Authority

The Notification of accident to AAIIB CAAP was relayed by the Operator of the aircraft to the OIC, AAIIB through to the Operation Center-CAAP at 1000H (LOCAL) on November 13, 2023.

Identification of the Investigation Authority

The Aircraft Accident Investigation and Inquiry Board (AAIIB), the mandated accident investigation organization within the Civil Aviation Authority of the Philippines (CAAP) as the state of Occurrence/Registry/ Operator conducted the investigation.

Organization of the Investigation

In accordance with provisions of Philippine Civil Aviation Regulation (PCAR) Part 13, an Investigator-In-Charge was appointed.

Authority Releasing the Report

The Final investigation report was released by Aircraft Accident Investigation and Inquiry Board (AAIIB) and published on the CAAP website on **24 March 2025.**

Synopsis:

On or about 0730H local time, November 13, 2023, a Cessna 152 type of aircraft with Registry Number RP-C8840 operated by Omni Aviation Corporation was substantially damaged during a forced landing following a total loss of engine power at Brgy. Tabing Ilog, Licab, Zaragoza, Nueva Ecija, Philippines. A private pilot (PP) license holder was the sole occupant and did not sustained any injury. Aircraft Accident Investigation and Inquiry Board determined that the cause factor of this accident was attributed to the failure of the engine crankshaft that resulted in the total loss of power.

LIST OF ACRONYMS AND ABBREVIATIONS

AAIIB	:	Aircraft Accident Investigation and Inquiry Board
AC	:	Advisory Circular
AGL	:	Above Ground Level
AANSOO	:	Aerodrome and Air Navigation Safety Oversight Office
ATOC	:	Aircraft Training Organization Certificate
BRGY	:	Barangay
CAAP	:	Civil Aviation Authority of the Philippines
FAA	:	Federal Aviation Administration
ID	:	Inside diameter
LCD	:	Licensing and Certification Division
MRO	:	Maintenance Repair and Overhaul
NTSB	:	National Transportation Safety Board
OD	:	Outside diameter
OES	:	Optical Emission Spectroscopy
OFSAM	:	Office of the Flight Surgeon and Aviation Medicine
PCAR	:	Philippine Civil Aviation Regulation
PP	:	Private Pilot
VFR	:	Visual Flight Rules
VMC	:	Visual Meteorological Condition

1. FACTUAL INFORMATION

Aircraft Registration No.	:	RP-C8840
Aircraft Type/Model	:	Cessna Aircraft Manufacturer/Cessna C-152
Operator	:	OMNI Aviation Corporation
Address of Operator	:	Manuel A. Roxas Hwy, Clark Freeport, Mabalacat, Pampanga, Philippines
Place of Occurrence	:	Brgy. Tabing Ilog, Licab, Zaragoza, Nueva Ecija, Philippines
Date/Time of Occurrence	:	November 13, 2023/0730H/1539 UTC
Type of Operation	:	Flight Training
Phase of Flight	:	Cruise
Type of Occurrence	:	Reciprocating engine – mechanical failure

1.1 History of Flight

On or about 0730H local time, November 13, 2023, a Cessna 152 type of aircraft with Registry Number RP-C8840 was substantially damaged during forced landing following a total loss of engine power at Brgy. Tabing Ilog, Licab, Zaragoza, Nueva Ecija, Philippines. A private pilot (PP) license holder, was the sole occupant of the aircraft operated by Omni Aviation Corporation, did not sustain any injury. Visual Meteorological Condition (VMC) prevailed at the time of the accident, and a VFR flight plan was filed.

During a solo navigational flight to Guimba from Zaragosa, both located in Nueva Ecija, Pangasinan, at an altitude of 2,000 ft AGL, the private pilot (PP) noticed a "roughness" in the engine. He saw that the engine oil pressure indication was "low," and a few minutes later, the engine loses its power. Several unsuccessful engine restarts were attempted while descending for a forced landing in a rice field. The aircraft initially touched down on its main gears and bounced after colliding with an embankment. The aircraft again landed on its nose wheel, 75 feet away from its initial touchdown. It continued to move forward for another 75 feet before the nose wheel collapsed and had a prop strike with the ground. The aircraft came to a complete stop in an inverted position with the last heading of 75 degrees and grid coordinates of 15°.566056 N; 120°.76875 E.

Figures 1 and 2. RP-C8840 on its final resting position.

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1.2 Injuries to Person (s)

Injuries	Crew	Passengers	Others	TOTAL
Fatal	0	0	0	**0**
Serious	0	0	0	**0**
Minor	0	0	0	**0**

1.3 Damage to Aircraft

The aircraft sustained substantial damage.

1.4 Personnel Information

1.4.1 Pilot

Gender	:	Male
Date of Birth	:	26 October 1997
Nationality	:	Filipino
License	:	151834 PPL
Valid up to	:	31 December 2023
Type rating	:	Airplane: Single Engine Land C152
Medical Certificate	:	Class II
Time on C152	:	156+ 49 Hours as per pilot logbook
Grand Total time	:	156+ 49 Hours as per pilot logbook

1.5 Aircraft Information

1.5.1 Aircraft Data

Registration Mark	:	RP-C8840
Manufacturer	:	Cessna Aircraft Company
Country Of Manufacturer	:	United States of America
Type/Model	:	Cessna 152
Operator	:	OMNI Aviation Corporation
Serial No.	:	15282354
Date of Manufacture	:	1979
Certificate of Airworthiness Valid up to	:	17 January 2024
Certificate of Registration Valid up to	:	05 June 2024
Number of Crew	:	1
Number of Passenger Seat	:	2
Airframe Total Time	:	18,608+50 Hrs.

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1.5.2 Engine Data

Manufacturer	:	Lycoming
Type	:	Piston
Model	:	0-235-L2C
Serial No.	:	RL-23652-15
Time Since New	:	12,402+09 Hrs.
Time Since Overhauled	:	582+02 Hrs.

1.5.3 Propeller Data

Manufacturer	:	Sensenich
Type/Model	:	Fixed Pitch 2 Blade/72CKS6-0-54
Serial No.	:	K10514
Time Since New	:	7,397+41

1.6 Meteorological Information

Visual Meteorological Conditions prevailed at the time of the occurrence.

1.7 Aids to Navigation

The flight was carried out under Visual Flight Rules (VFR). In using VFR, the pilot must be able to operate the aircraft with visual references to the ground and visually avoid obstructions and other aircraft.

1.8 Communication

The aircraft was equipped with a standard radio transceiver, communications were carried out between the pilot and other aircraft within the area.

1.9 Aerodrome Information

Omni Aviation Corporation Aerodrome is a small airport in Mabalacat, Pampanga, Philippines. The ICAO designator of this field is PH-0178. It is listed as private aerodrome facility under the CAAP aerodrome and air navigation facility under the Aerodrome and Air Navigation Safety Oversight Office (AANSOO).

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Aerodrome Name	:	Omni Aviation Corporation Aerodrome (PH-0178)
Coordinates	:	15°10'12.42" N 120°33'46.85" E
Aerodrome Operator	:	OMNI Aviation Complex, Manuel A. Roxas Highway, Clark Special Economic Zone Field, Pampanga
Runway Direction	:	02/20
Runway Length	:	640 meters
Runway Width	:	16 meters
Runway Elevation	:	170.41 m AMSL
Surface	:	Asphalt Strength: 5,455 kg. AUW
Slope	:	0.14%
Types of traffic permitted	:	VFR
AD Operator	:	Airport Operations: 2200Z – 0800Z.
Security	:	H24
Restaurants	:	At the town proper
Transportation	:	Vehicle for hire.
Visual Ground Aids	:	Standard day markers and wind direction indicator.
Facilities	:	Hangar, flight dispatch station, radio transceiver, refueling station, first aid kit, firefighting equipment and land transportation.
Capability for removal of disabled aircraft	:	Nil
Cautions:	:	RWY 02 approach is displaced 200m from threshold to provide adequate clearance from Subic-Tarlac-Clark Expressway overpass.

1.10 Flight Recorders

The aircraft was not equipped with any flight recorders and existing CAAP regulation does not require it.

1.11 Wreckage and Impact Information

The aircraft initially touched down on its main gears and bounced after colliding with an embankment. The aircraft again landed on its nose wheel, 75 feet away from its initial touchdown. The aircraft continued to move forward for another 75 feet before the nose wheel collapsed, resulting in a prop strike with the ground. The aircraft came to a complete stop in an inverted position, with the last heading being 75 degrees and the grid coordinates being 15°. 566056 N; 120°.76875 E.

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1.12 Medical and Pathological Information

Following the incident, the PP underwent a medical and drug test, which revealed no significant medical findings. The Office of the Flight Surgeon and Aviation Medicine (OFSAM) also conducted a post-accident medical examination and there was no medical impediment that hindered the pilot's fitness to fly.

1.13 Fire

No evidence of post impact fire was noted during on-site investigation.

1.14 Search and Survival Aspects

The pilot egressed safely on his own after performing engine shutdown and was able to inform the operator of the incident. Immediately, the company emergency response plan was activated. The Fire Rescue Brigade Team arrived on the scene after 1 hour and 40 minutes.

1.15 Test and Research

The engine was removed from the aircraft and was brought to the operator's hangar last November 13, 2023. A teardown inspection by the operator contracted third-party AMO and witnessed by the AAIIB investigators was conducted on the engine. It was determined that the crankshaft was fractured in two, and the number 3 connecting rod had separated from the crankshaft. The AAIIB-CAAP, in conjunction with the National Transportation Safety Board (NTSB), had also requested Lycoming Engines USA to further examine the crankshaft and connecting rod.

1.16 Organization and Management Information

1.16.1 Operator

OMNI Aviation Corporation has an Aircraft Training Organization Certificate (ATOC) #96-09B. OMNI Aviation started operations in 1993. It is authorized to perform Flight and Ground Training Operations that provides Private Pilot Course, Single-Engine/Muli- Engine Land Commercial Pilot Course, Flight Instructor Course and Instrument Rating for Airplane, Airline Transport Pilot License, and Ground Theory and Jet Orientation Training. It also has Cabin Crew Training, Airline Services Training, and Aircraft Maintenance Training. It is located at Manuel A Roxas Highway, Clark Freeport Zone, 2009 Clark, Philippines.

1.16.2 Maintenance

The maintenance function of RP-C8840 was undertaken by OMNI Aviation Corporation Repair Station with a current Approved Maintenance Organization (AMO) Certificate number 96-10 located at Manuel A Roxas Highway, Clark Freeport Zone, Clark, Philippines.

2. ANALYSIS

2.1 General

The pilot reported that during the solo navigation flight to accumulate flight time, he noticed that the aircraft had a roughness in its engine. A few minutes later, the aircraft completely lost its power. The pilot tried to restart the engine to no avail. He then decided to make a forced landing in an open rice field, and came to rest in an inverted position.

2.2 Flight Crew

The pilot has a valid license issued by Licensing and Certificate Department (LCD) for such type of aircraft. At the time of the accident, the pilot had accrued a total of 156+49 hours of flight time on this particular type of aircraft. The pilot also stated that there were no noted abnormalities on the aircraft before the flight.

2.3 The Engine Teardown Inspection

The engine was removed from the aircraft and was brought to the operator’s hangar last November 13, 2023. The engine teardown report dated November 14, 2023, indicates that after the oil sump was removed, a punch hole approximately 2.50-2.75 inches in diameter at the bottom of the right crankcase half was seen (figures 3 and 4). It was caused by the nos. 3 connecting rod. The oil pump was also found stuck due to the misalignment pressure applied by the broken crankshaft end to the oil pump drive.

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Figure 3 and 4 - Punch hole made by the connecting rod number 3

The cylinders number 1, 2, and 4 were removed from the crankcase, however cylinder number 4 was removed with force due to the damage at the bottom part of the piston and cylinder respectively. The damage was caused by the connecting rod being separated from the crankshaft that resulted to the interlocking with another piston, and cylinder. (figure 5). Moreover, after the crankcase was separated, the crankshaft assembly was found fractured at the crank pin journal number 3 (figure 6).

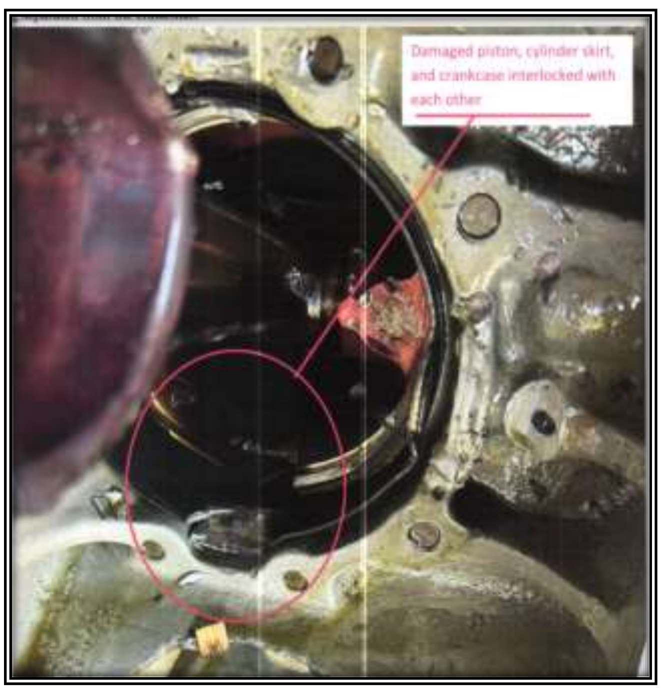
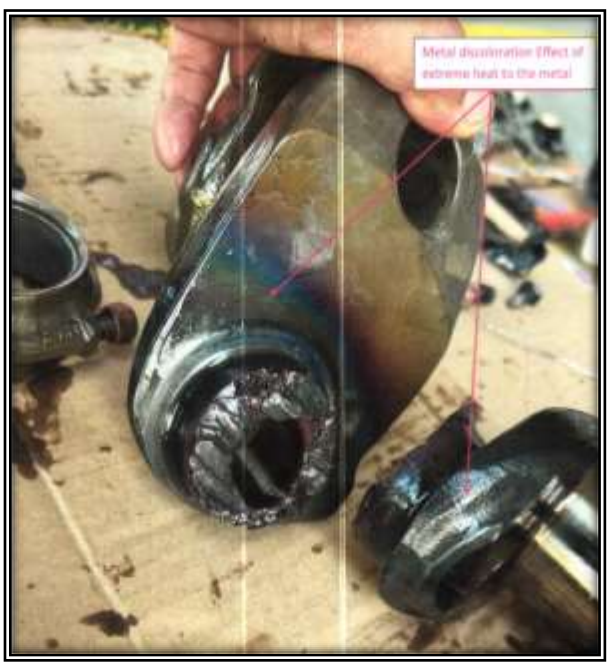


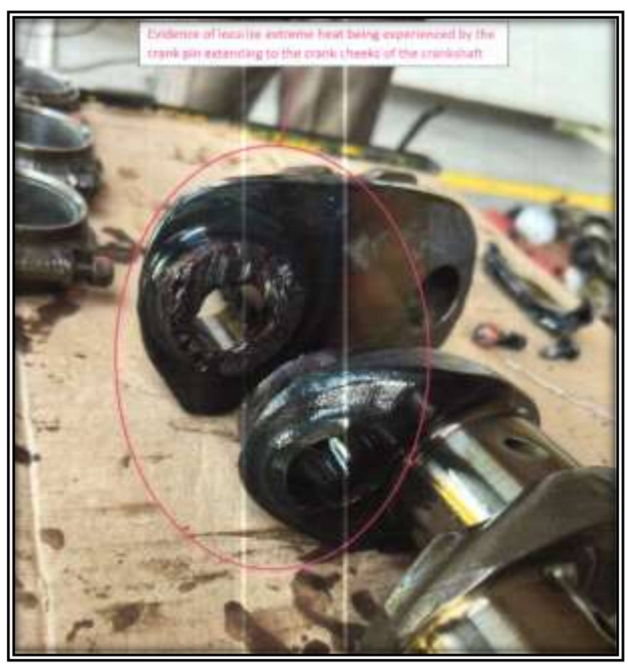
Figure 5 - Damaged piston, cylinder skirt and crankcase interlocked with each other.

Figure 6 - Crankshaft assembly fractured at crank pin journal number 3.

2.4 Observations based on evidences

During the teardown inspection, the number 3 crank pin journal fractured area had an indication of extreme heat damage to the metal. This was indicated by the black and bluing discoloration of the metal extending to the crank checks area of the crank pin (figures 7 and 8).





Figures 7 and 8 - The metal discoloration due to extreme heat.

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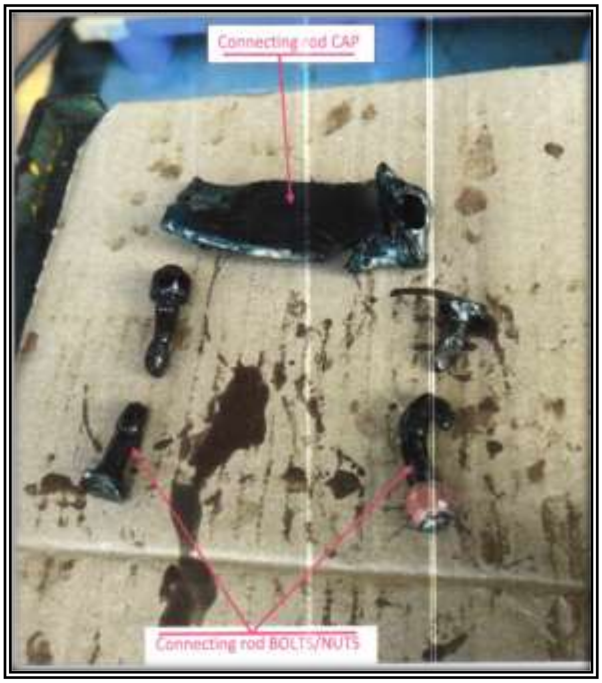
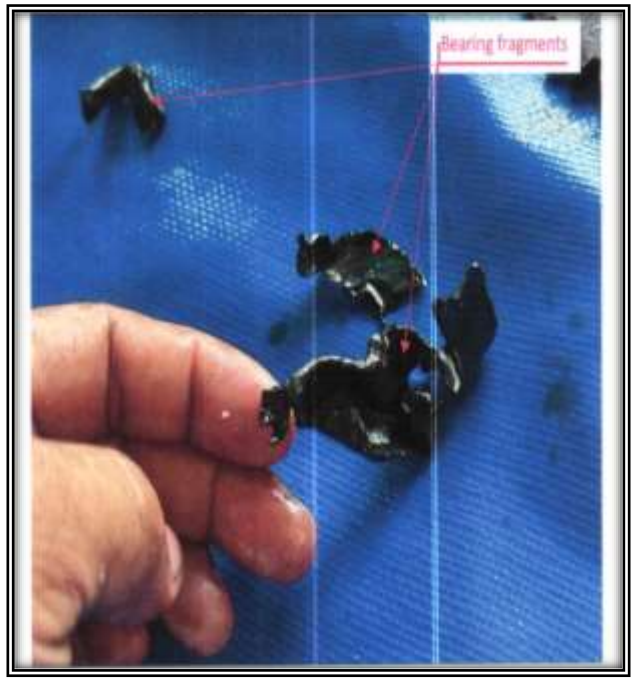
There was also evidence that the number 3 connecting rod bolts and bearing was subjected to an extreme heat resulting for them to be stretched and fractured (figure 9 and 10).





Figures 9 and 10 - Fractured connecting rod bolts and bearing fragments.

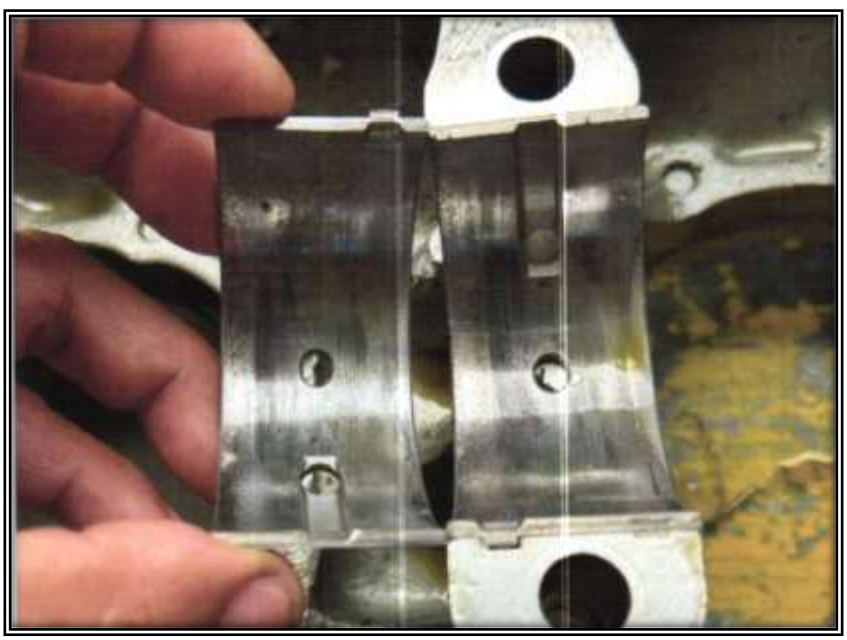


Figure 11 - Photo of undamaged bearing (For reference only).

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Further observations revealed that the separated connecting rod number 3 had evidence of being hit by the crankshaft pin journal number 3. This caused for the connecting rod to be deformed and damaged the bottom side of the piston and cylinder skirt respectively. There was also the punched hole seen at the bottom area of the right crank case half (figure 12).

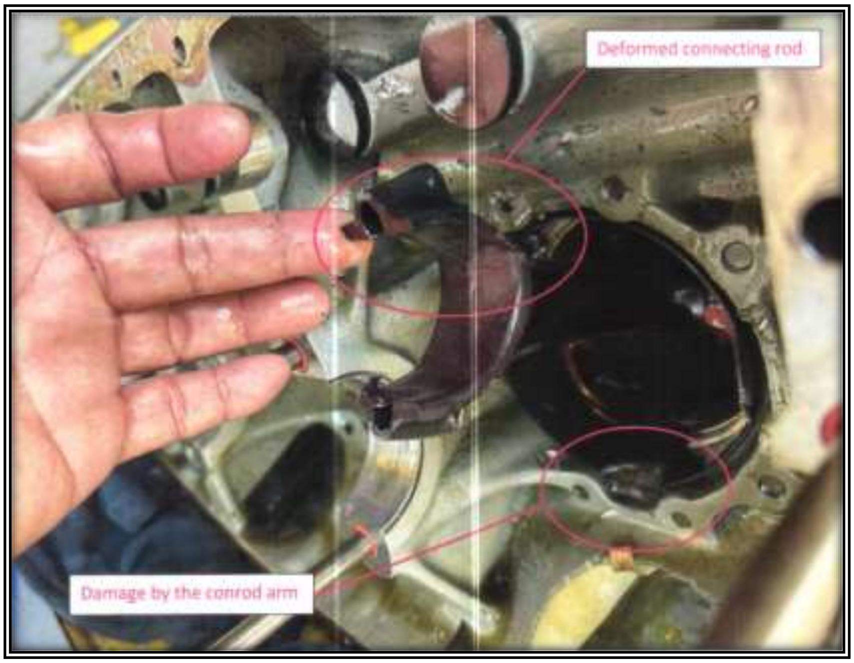

Figure 12 - Deformed connecting rod and punched hole in right crankcase half.

2.5 Lycoming Materials Laboratory Investigation Report

With the findings from the teardown inspection, the AAIIB-CAAP, in conjunction with the NTSB, have also requested Lycoming Engines Company to examine further the engine crankshaft, connecting rods, bearings, and hardware of RP-C8840.

2.5.1 Crankshaft Evaluation and Test Result

The crankshaft as was in received condition is shown in figure 13. The two halves of the crankshaft were identified as the front sample and rear sample. The crankshaft was fractured completely at the number 3 crankpin near the center of the crankpin, not through either of the journal fillet radii. Significant heat discoloration was observed that spread from the fracture location onto the nearby cheek number 4 and cheek number 5 surfaces, indicating a significantly high temperature was experienced in this localized area.

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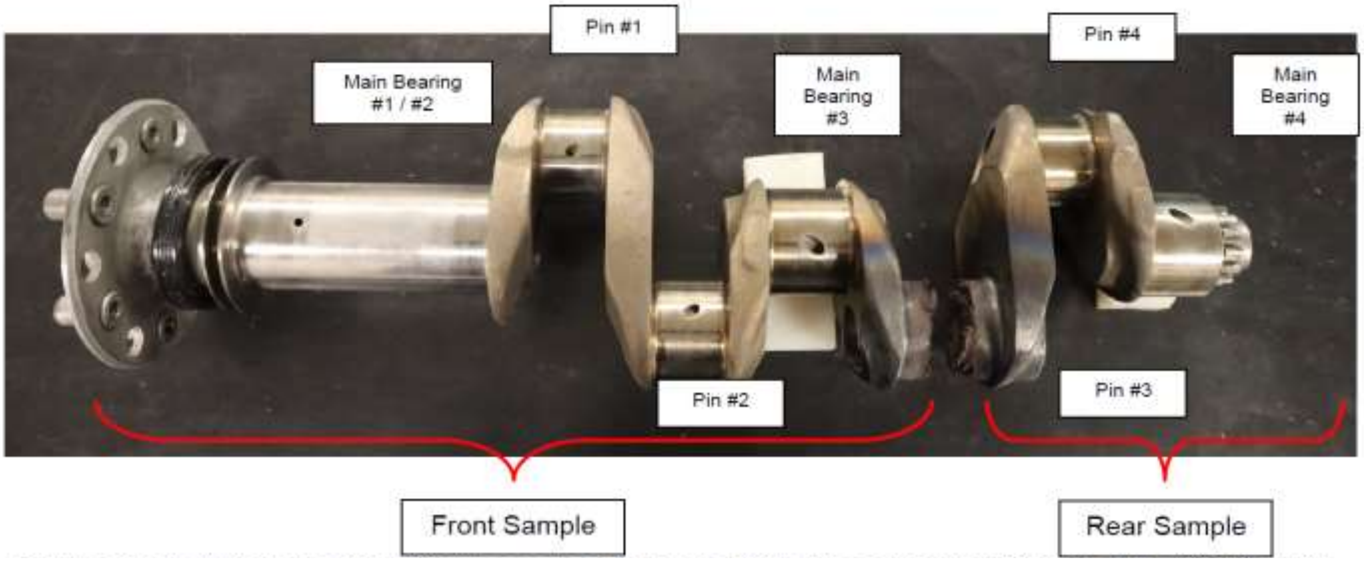

Figure 13 - Fractured crankshaft in the as-received condition.

Dimensional measurements were made on the main journals along with the crankshaft pins. The number 3 pin was unable to be measured for dimensional conformances due to the damage sustained in that area. The dimensional measurements were recorded by a Lycoming Engines final inspector with the use of snap gages. All measurements were noted to be standard and conforming dimensionally.

The two halves of the crankshaft were evaluated via magnetic particle inspection to determine if any additional indications were present on the crankshaft. In figures 14 and 15, the front sample fracture surface was shown with multitude of additional cracks visible adjacent to the main fracture. An additional larger crack was visible on the ID of the front sample. The cracking likely corresponds to heat checks.

Figures 14 and 15 - Front sample surface during fluorescent dye mag particle inspection

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The fracture surface from the front sample is shown in figure 16. The fracture surface has signs of contact damage, likely from contacting the rear sample while the engine was still operating. In figure 17, subsurface cracking was present in a region of overload failure. Metal smearing observed is shown in figure 18.

Figure 16 - Fracture surface from the front sample.

Figure 17- Subsurface cracking is present in a region of overload failure.

A side view of the front sample fracture surface is shown in figure 19 and figure 20. In both figures, secondary cracking was observed to extend from the fracture surface and into the material. The cracks are also observed at a 45-degree angle, which may be indicative of torsional stresses. Figure 21, outlines cracking manifested by the oil hole region on the pin that was also surrounded by significant flattening of the fracture surface from contact damage.

Figure 18 - 20x original magnification of the smeared metal on the fractured surface.

Figure 19 - 30x original magnification of the side view of the top fracture surface.

Figure 20 - 30x original magnification of the side view of the fracture surface from the front sample.

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Figure 21 - 20x magnification of the damage on the outer diameter of the number 3 Pin on the front sample.

The fracture surface from the rear sample was shown in figure 22. Similar to the front sample, the fracture surface has many signs of contact damage and material smearing, which occurred after fracture. Figure 23 is an example of contact damage, along with additional material cracking present. A side view of the rear sample fracture surface is shown in figure 24 and figure 25. The jagged, alternating 45-degree crack parallel to the fracture surface is evidence of torsional fatigue.

Figure 22 - 20x original magnification stitched image of the fracture surface from the rear sample.

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Figure 23 - 20x original magnification of a region of chipped and damaged material on the fracture surface of the rear sample.

Figure 24 - 30x original magnification of the side view of the top fracture surface from the rear sample.

Figure 25. Original magnification of the side view of the top fracture surface from the rear sample, rotated 90 degrees clockwise.

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The rear sample fracture surface was evaluated via Scanning Electron Microscope (SEM), are shown in figures 26 to 28. In most locations, the fracture surface was either flattened or smeared, thereby removing any additional evidences of the failure mode of the fracture. Energy Dispersive X-ray Spectroscopy (EDS) was performed on the fracture surface with indications of iron and oxygen, indicative of iron oxide, along with carbon and lead from the combustion environment of the engine. EDS results are also outlined in figure 28.

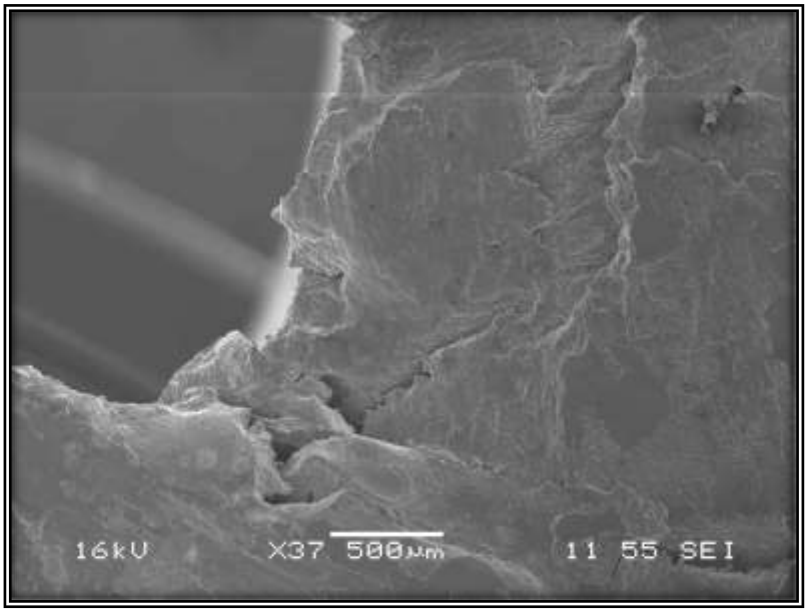

Figure 26 - 37x original magnification SEM image of the fracture surface of the rear sample.

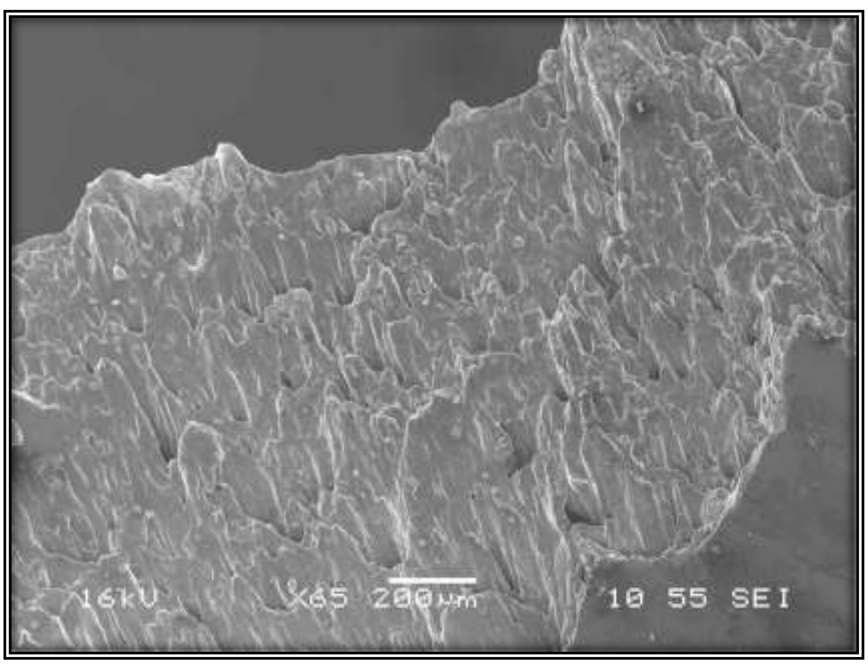

Figure 27 - 65x original magnification SEM image of the fracture surface of the rear sample.

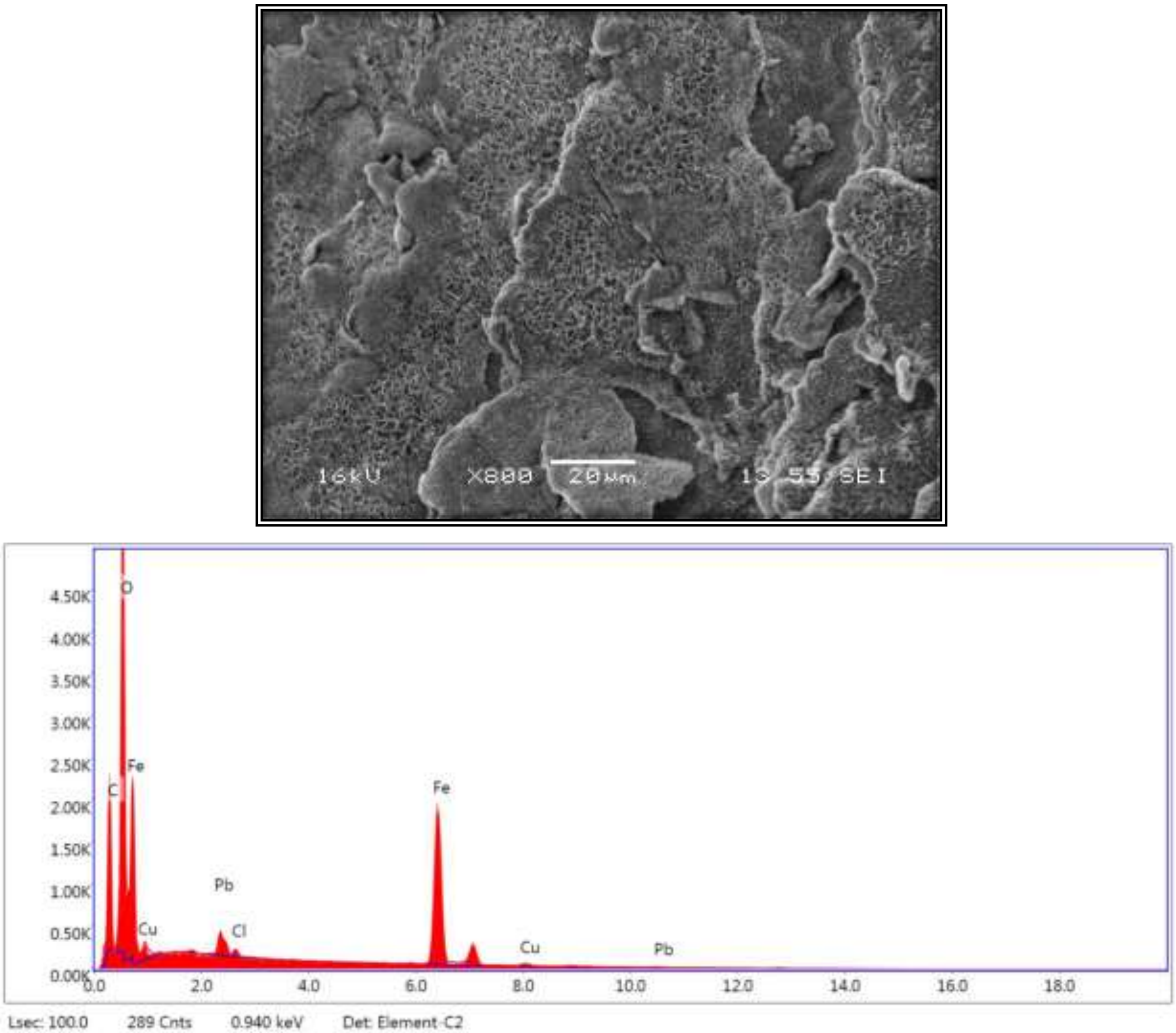

Figure 28 - 800x original magnification SEM image of the fracture surface of the rear sample with EDS results

The fracture surface of the rear sample was sectioned in order to obtain a sample for hardness and microstructural analysis. The location of the sample section is shown in Figure 29, with the sectioned surface mounted face-down. Due to the damage that was sustained to the number 3 pin and its fracture surfaces, the values reported are for information only and should not be utilized as a judge of material conformance. Core hardness was measured at 55.5 ± 1.0 HRC, which is significantly higher than the requirement of 32 - 39 HRC. Two microhardness traverses were placed, one on the ID and one of the OD of the sectioned sample. The microhardness profile is shown in figure 30, with the results recorded in HV then converted to HRC. The average hardness was 56 HRC, and no case depth was observed. For reference, the hardness value recorded is significantly higher than the 64 HR30N minimum requirement for the case hardness.

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Figure 29. Reference location for the sectioned sample obtained from the fracture surface of the rear sample.

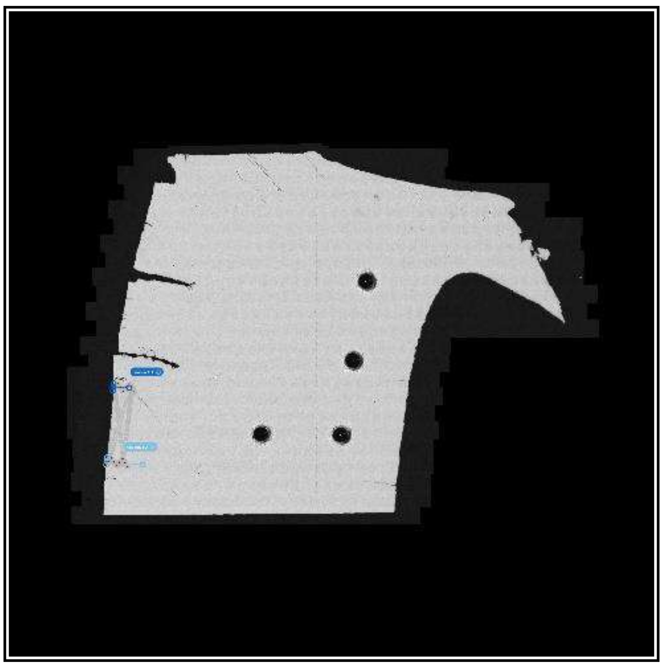

Figure 30 - Microhardness traverses that were placed on the ID and OD surfaces of the sectioned rear sample.

Multiple cracks are visible along both the ID and OD of the sample cross-section, with the largest crack visible in figure 31, with the maximum separation of 0.02157 inches. Additional cracking was observed likely resultant of heat checks stemming from rapid temperature changes during the failure is shown in figure 32. The sample was etched with nital to view the microstructure, which consist of tempered martensite in the core, is shown in figure 33. The case microstructure consists of fine grains with small

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particles lining the grain boundaries, likely of carbide and nitride particles is shown in figure 34. There are fine grains present in the microstructure immediately below the scale layer on the OD and extend approximately 0.024 inches into the material. The altered microstructure of the case was observed on the ID, OD, and in some regions along the fracture surface. The microstructure difference was indicative of a significant heat event, which altered the microstructure from the typical tempered martensite and dispersed nitrides at the case. A white layer with a thickness of 0.00075 inches from the original gas nitride heat treatment process was visible along the ID of the sample is shown in figure 35.

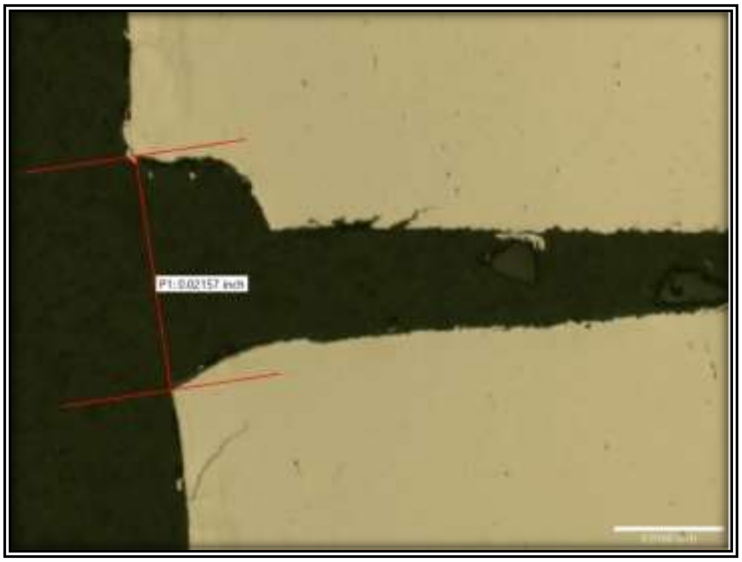

Figure 31. 50x original magnification of the largest crack separation on the sectioned rear sample.

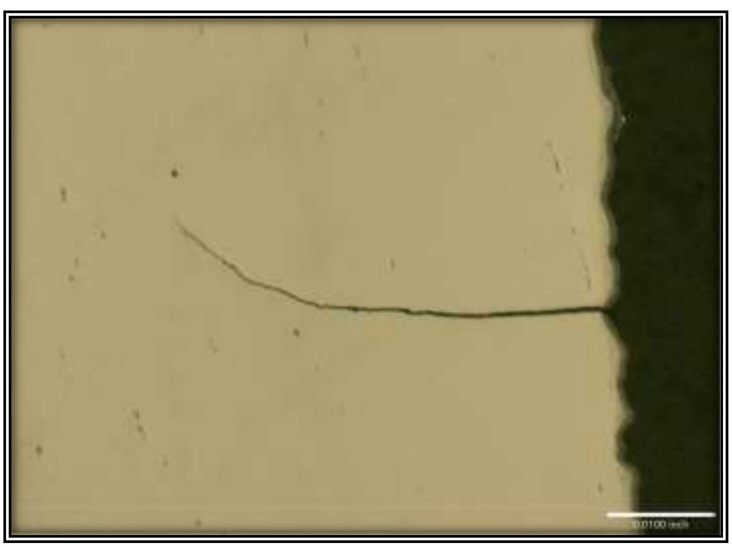

Figure 32 - 50x original magnification of a heat check crack visible on the ID of the sectioned rear sample.

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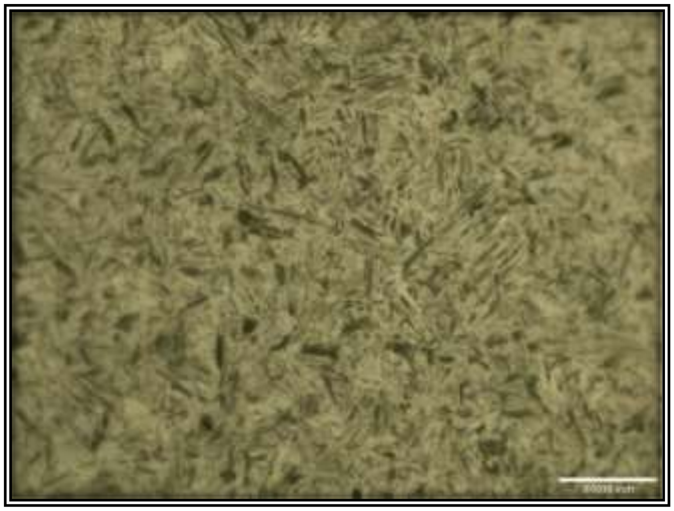

Figure 33 - 500x original magnification of the core microstructure of the sectioned rear sample after being etched with nital.

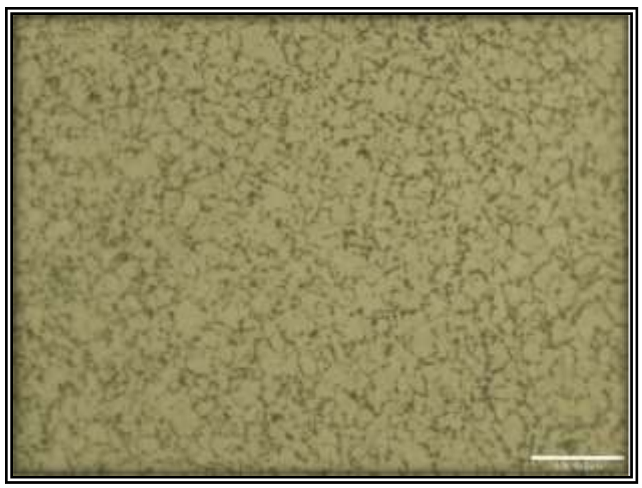

Figure 34 - 500x original magnification of the case microstructure of the sectioned rear sample after being etched with nital.

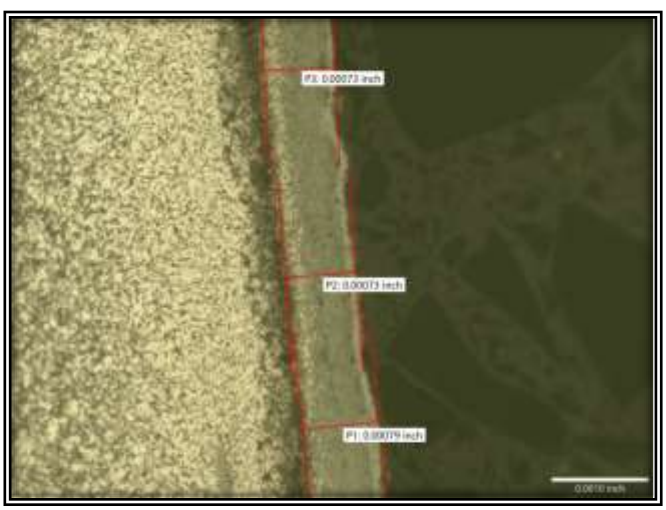

Figure 35 - 500x original magnification of the case microstructure of the sectioned rear sample after being etched with nital.

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Along the OD of the sample, additional cracking was present is shown in figure 36. Adjacent to the main crack, subsurface cracking was also observed is shown in figure 37. The path for both the main crack and adjacent crack followed an alternating 45-degree path, which was evidence of torsional loading. The cracking also appeared to propagate along grain boundaries. Along the fracture surface, as seen in figure 38 and figure 39, oxide scale was observed along with the fine grain structure with precipitated particles along the grain boundaries. The oxide scale was likely due to excessive heat exposure after the fracture occurred. Rehardening along the fracture surface and evidence of contact damage via grain flow deformation are also observed.

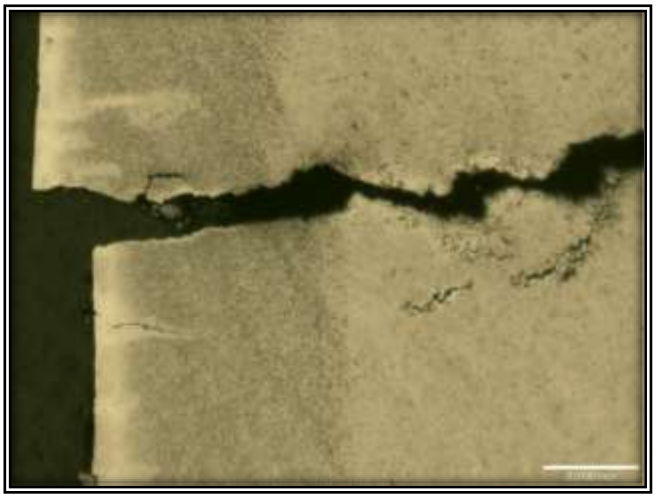

Figure 36 - 50X original magnification of an additional crack observed on the OD of the pin surface of the sectioned Rear Sample after being etched with nital. The upper portion of the crack is displaced with respect to the lower section, which is a sign of unusual loading in the region.

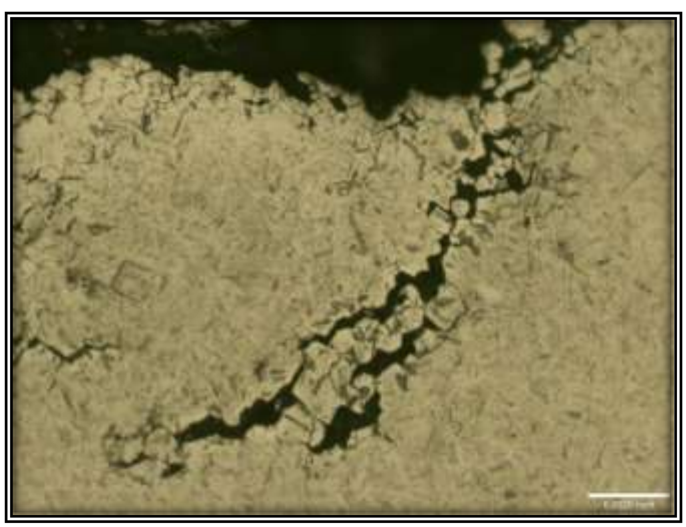

Figure 37 - 200X original magnification of the sub-surface cracking adjacent to the OD crack of the number 3 Pin after being etched with nital. The crack appears to follow a branching, intergranular path.

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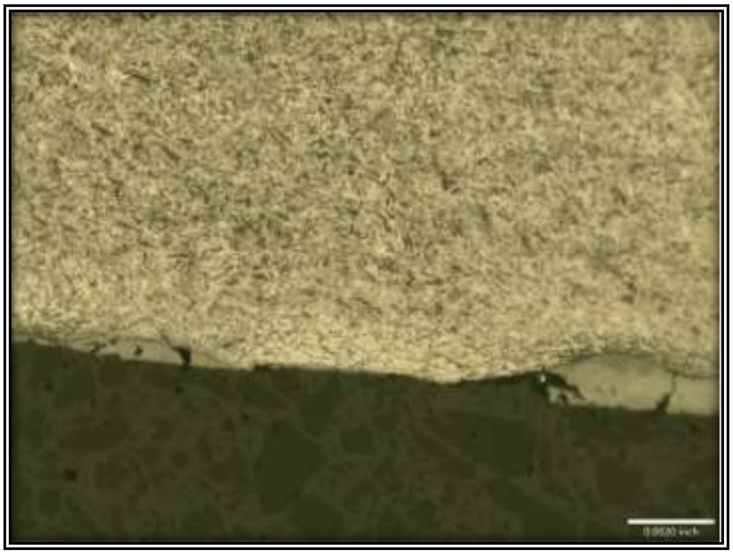

Figure 38 - 100X original magnification of the fracture surface of the sectioned rear sample after being etched with nital.

The fractured surface contain signs of an oxide scale layer, indicating that it was exposed to significant temperatures after fracture. The fine grain microstructure was visible at the fracture surface, while it transitions to tempered martensite away from the surface.

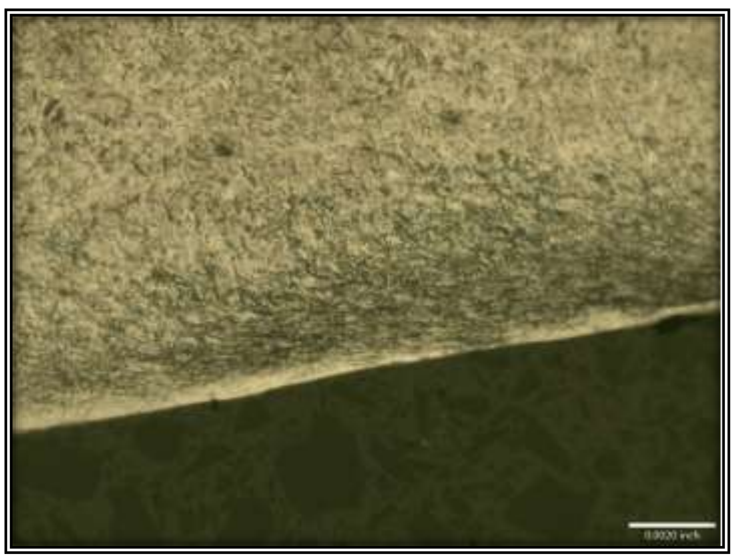

Figure 39 - 200X original magnification of the fracture surface of the sectioned rear sample after being etched with nital.

The fractured surface shows signs of rehardening due to high temperatures. The microstructure near the surface indicates material deformation due to the change observed in the grain flow.

The number 1 pin was sectioned and evaluated for conformance as a reference for the condition of the number 3 pin. After being etched with nital, the core of the sectioned sample of the number1 pin was observed to consist of tempered martensite shown in figure 40, is conforming. The case microstructure consisted of tempered martensite and dispersed nitrides is shown in figure 41. Patches of white layer from nitride treatment were also visible. The core hardness of the pin was 34.0 ± 0.1 HRC, which is conforming. The case depth of the pin with an average value of 0.0245 inches, is conforming to the requirement of 0.018 – 0.026 inches.

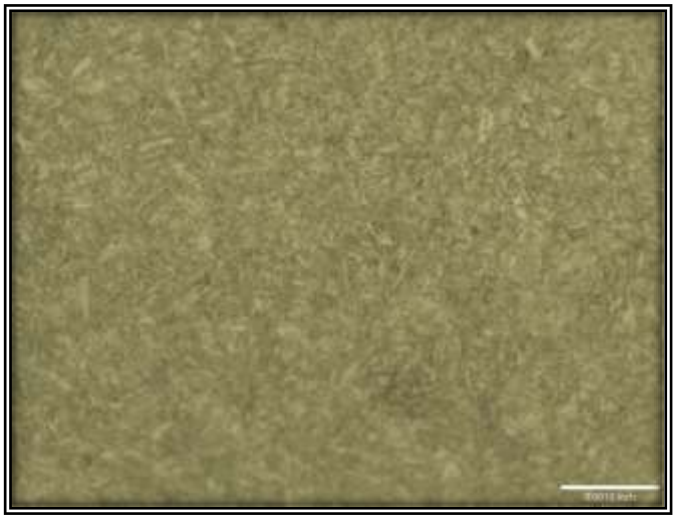

Figure 40 - 500X original magnification of the core microstructure of Pin number 1 after being etched with nital. The core microstructure consists of tempered martensite, which is conforming.

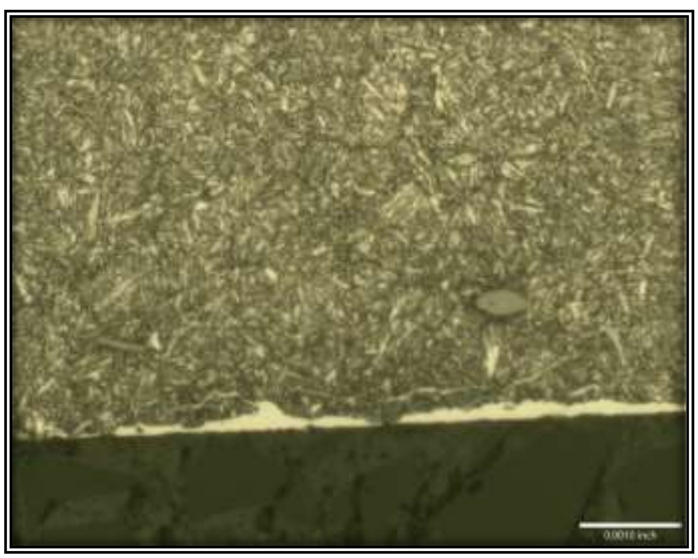

Figure 41- 500X original magnification of the case microstructure of Pin number 1 after being etched with nital. The case microstructure consists of tempered martensite and dispersed nitrides, which is conforming. Some regions of the white layer from the nitride process are present.

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A section of the number 2 cheek was isolated and prepared for conformance testing away from the region of failure. The average core hardness that was obtained was 34.4 ± 0.1 HRC, which is conforming to the 32 - 39 HRC requirement. Several microhardness traverses were placed on the sectioned sample. The sample was etched with nital to observe the case and core microstructures. The case consisted of tempered martensite and dispersed nitrides. The white layer measured 0.00053 inches thick, is shown in figure 42. The core microstructure consists of tempered martensite is shown in figure 43. Both the case and core microstructures were conforming to LPS-366 and LPS-468. The sample was also evaluated via Optical Emission Spectroscopy (OES) and was found to be consistent with the requirement of AMS steel 6415 with a slightly elevated carbon percentage.

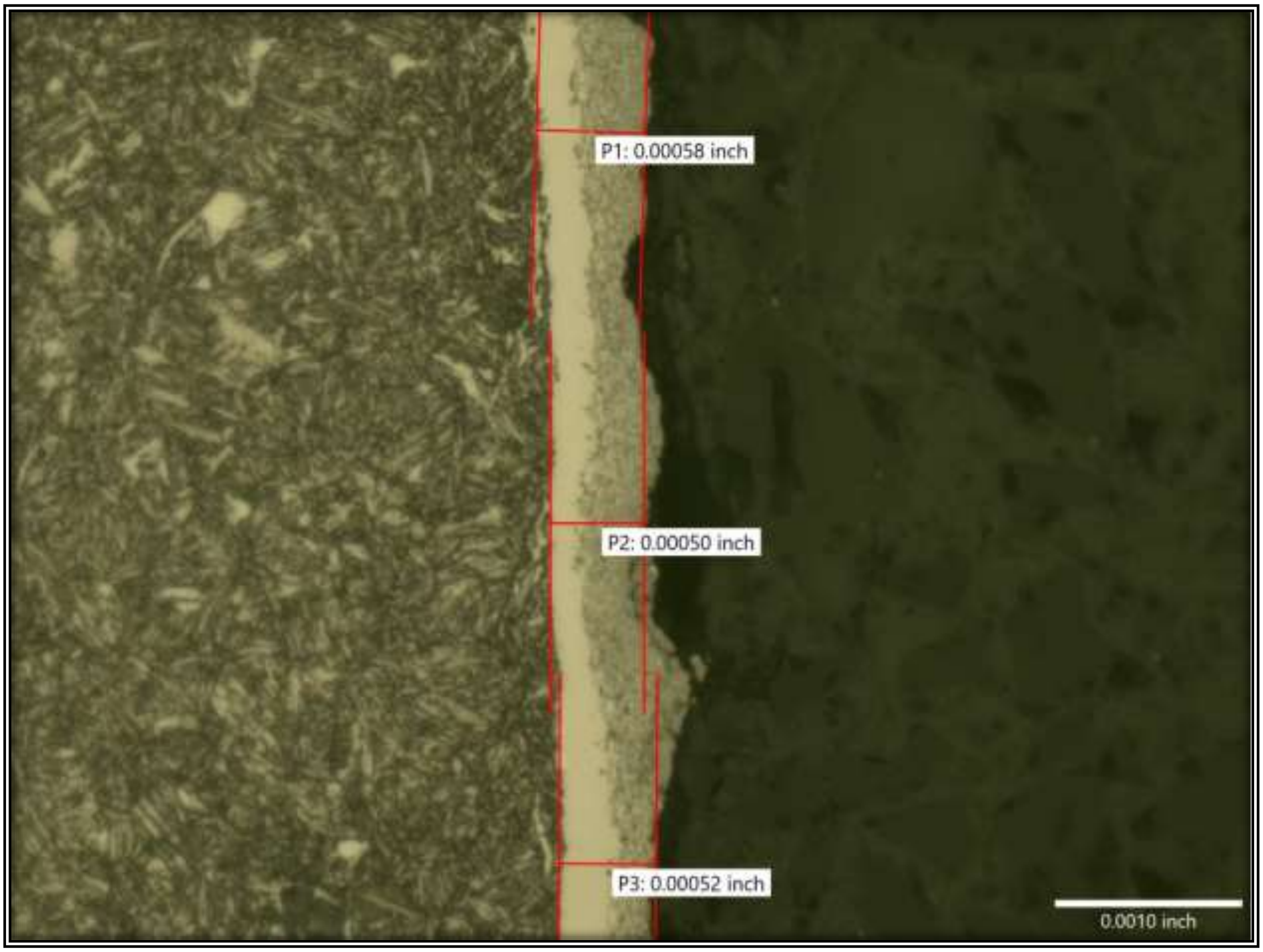

Figure 42 - 500X original magnification of the case microstructure of Cheek number 2 after being etched with nital. The case microstructure consists of tempered martensite and dispersed nitrides. The white layer averaged a thickness of 0.00053 inches.

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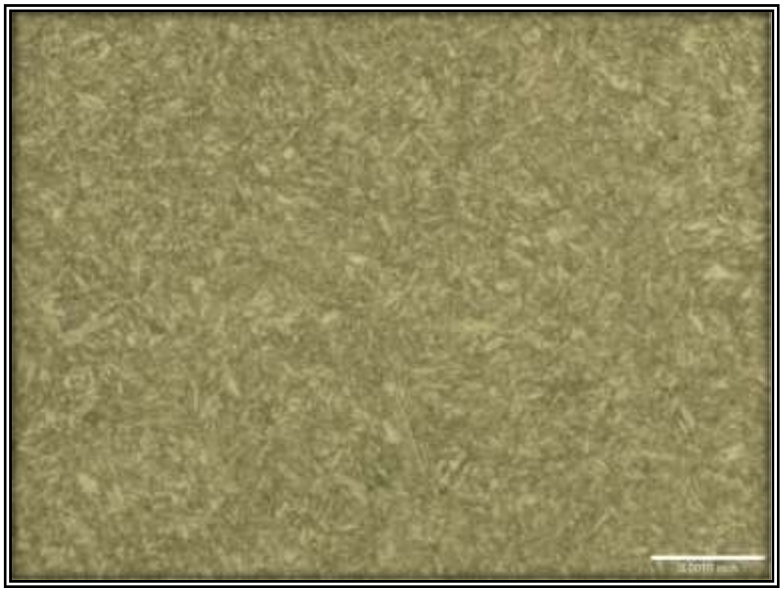

Figure 43 - 500X original magnification of the core microstructure of Cheek number 2 after being etched with nital. The core microstructure consists of tempered martensite, which is conforming.

2.5.2 Number 3 Connecting Rod

The damaged number 3 connecting rod is shown in figure 44 in the as received condition. The connecting rod experienced significant heat damage, was noted by the darkened color stemming from the cap location and down the handle. The connecting rod cap, bolts, nuts, and bearings were all separated from the assembly upon receipt. Additional contact damage on the connecting rod is shown in figure 45 and figure 46. In figure 47, shows the bent out of round shape of the material deformation that was experienced.

Figure 44 - The number 3 connecting rod in the as-received condition. The connecting rod experienced significant contact and heat damage. The connecting rod cap, bolts, nuts, and bearings were all separated from the assembly.

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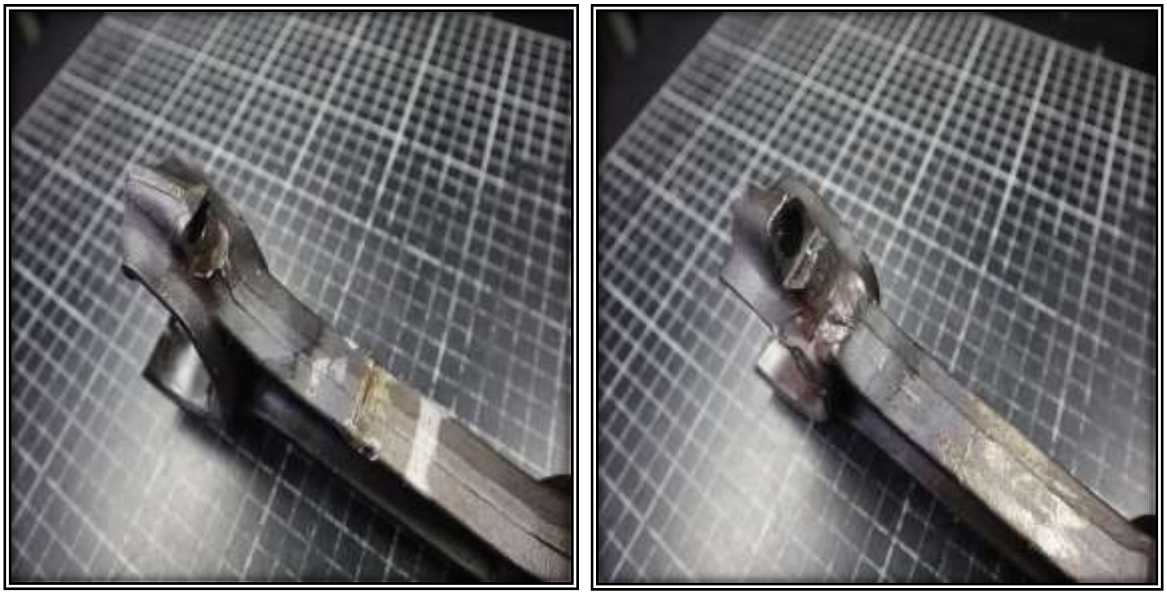

Figure 45 - Additional damage sustained to the number 3 connecting rod.

Figure 46 - Additional damage sustained to the number 3 connecting rod, noted by the deep gouge and material smearing.

Figure 47 - Additional damage sustained to the number 3 connecting rod. The connecting rod is bent out of round with material cracking along the contact surfaces.

Additional components from the number 3 connecting rod assembly are shown in figure 48, consist of additional 7 pieces that correspond to the bearings and connecting rod bolts. The connecting rod cap shown in figure 49, has an evidence of heat damage, deep material gouging, and a flattened shape. The bearing pieces shown in figure 50, are severely heat damaged with discoloration and cracking. The bearings also sustained significant material loss. The two connecting rod bolts both fractured in the middle of the bolt, resulting in two halves of each bolt, is shown in figure 51 and figure 52. The fracture surfaces of both bolts were damaged, that the mode of failure could not be determined.

Figure 48 - Additional pieces of the number 3 connecting rod in the as-received condition.

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Figure 49 - The number 3 connecting rod cap piece. Significant deformation occurred to the shape of the cap, along with deep gouging on the part surface.

Figure 50 - Additional damaged pieces returned along with the number 3 connecting rod. The two pieces appears to be the damaged bearings associated with this connecting rod assembly. Both bearings have sustained significant material loss, deformation, and heat discoloration.

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Figure 51 - Two fractured connecting rod bolt pieces associated with the number 3 connecting rod. Both bolts fractured in the stem, and sustained damage to both the stem and head.

Figure 52 - Two remaining halves of the fractured connecting rod bolts along with their associated nut. Both bolts are fractured in the stem and contain significant deformation and gouging.

2.5.3 Other connecting rods

The remaining connecting rod for cylinders 1, 2, and 4 were also evaluated. The number 1 connecting rod assembly is shown in figure 53. It was noted that the number 1 connecting rod has different forging number than the other rods, indicating that it was likely replaced in the field. The number 1 connecting rod was noted to have a conical wear mark on the ID of the bearings is shown in figure 54. Minor signs of damage were observed on the outer circumference of the connecting rod is shown in figure 55. The bearings were removed from the assembly with more severe scratching on the ID is shown in figure 56.

Figure 53 - The number 1 connecting rod in the as-received condition. Minor signs of wear and damage were observed.

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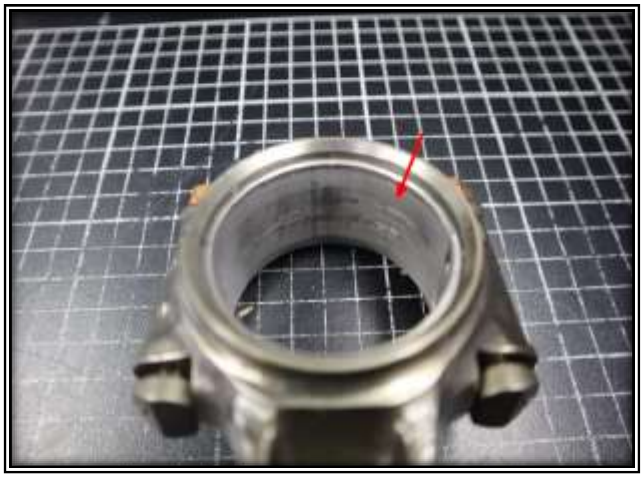

Figure 54 - On the number 1 connecting rod, deep wear grooves were observed on the interior of the connecting rod bearing, as indicated by the arrow.

Figure 55 - The contact damage sustained to the outer circumference of the number 1 connecting rod.

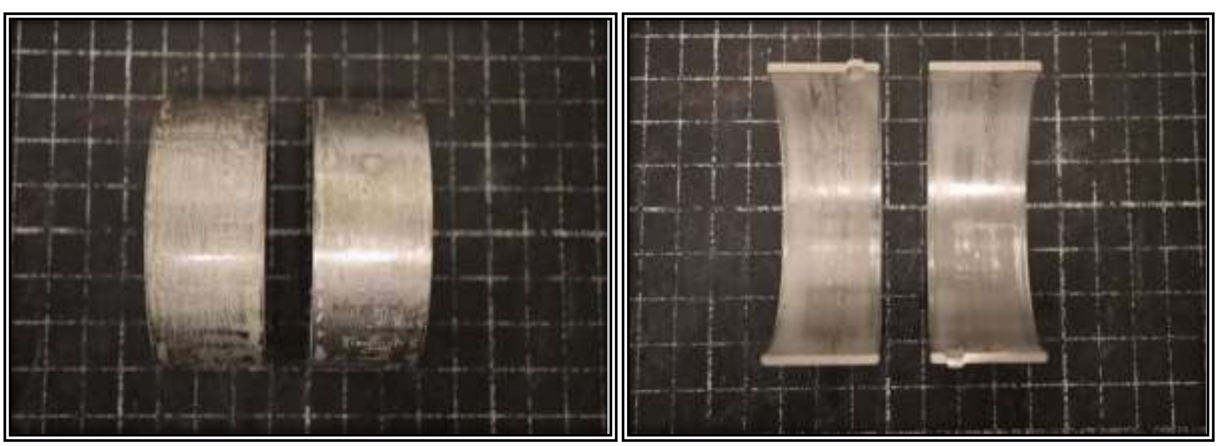

Figure 56 - The connecting rod bearings after being removed from the number 1 connecting rod assembly. Two deep wear marks are present on one of the bearings.

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The number 2 connecting rod assembly is shown in figure 57, with no noteworthy signs of damage sustained to the rod itself. The bearings were removed from the connecting rod assembly, and a small scratch was noted on the ID contact surface of one of the bearings is shown in figure 47. Otherwise, the bearings had standard wear.

Figure 57 - The number 2 connecting rod in the as-received condition. Minor signs of wear and damage were observed.

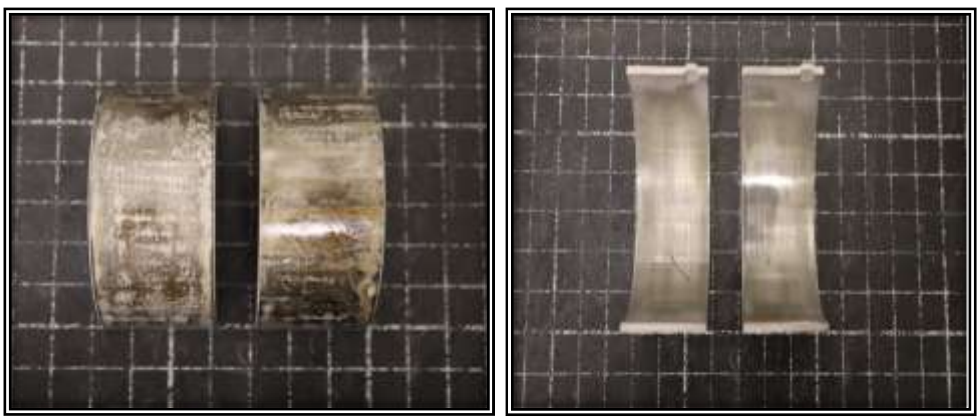

Figure 58 - The connecting rod bearings after being removed from the number 2 connecting rod assembly. A jagged scratch was observed on one of the bearings, with standard wear otherwise.

The number 4 connecting rod assembly is shown in figure 59 in the as-received condition. Some damage likely from debris from the fracture was sustained by the I-beam section of the connecting rod, is shown in figure 60. Signs of material smearing and heat tinting are present near the connecting rod bolts is shown in figure 61.

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Figure 59 - The number 4 connecting rod in the as-received condition.

Figure 60 - Damage sustained to the I-beam section of the number 4 connecting rod

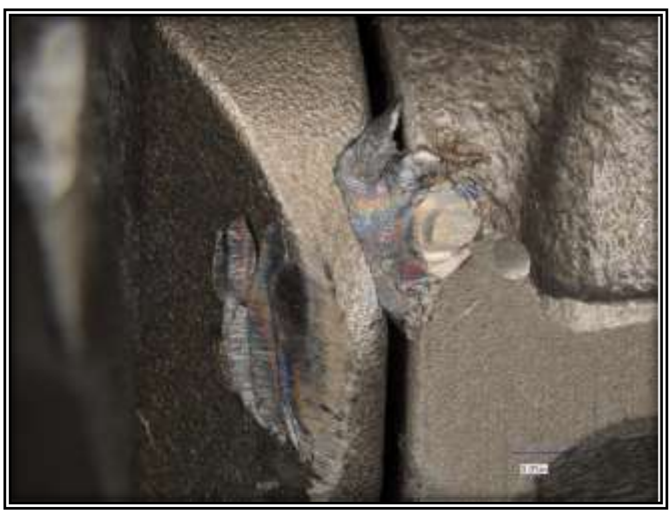

Figure 61 - Damage sustained to the number 4 connecting rod in the region of the connecting rod bolt. Material is smeared from contact damage and displays signs of heat tinting.

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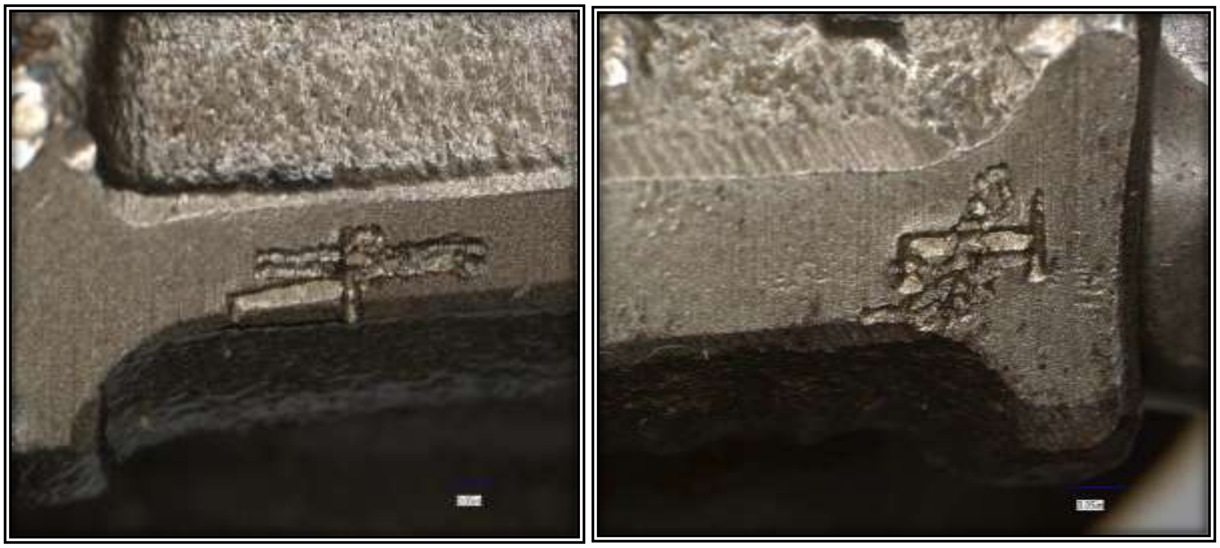

Figure 62 - Both halves of the connecting rod assembly appear to have had their initial cylinder number (1) marking vibro opened over to resemble a 4. This indicates that this connecting rod is not the initial part.

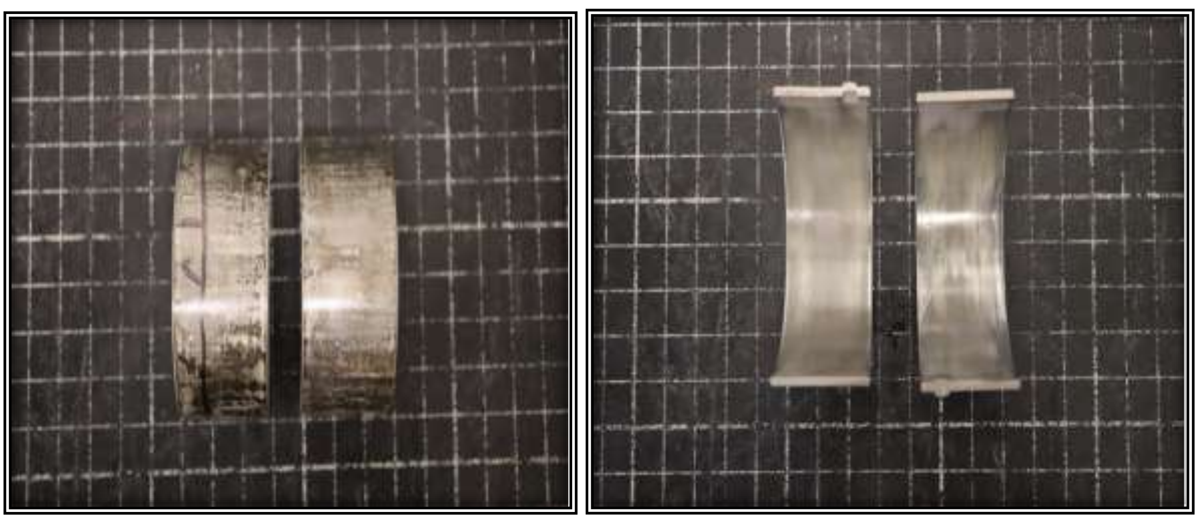

Figure 63 - The connecting rod bearings after being removed from the number 4 connecting rod assembly. A jagged scratch was observed on one of the bearings, with standard wear.

2.6 Lycoming Materials Laboratory Investigation

Based on the Lycoming Materials Laboratory Investigation, it was concluded that the crankshaft failed completely at the number 3 crankpin. Additional components in the region of failure also experienced significant damage, such as the number 3 connecting rod and its components. Significant heat was experienced at the fracture location as indicated by the severe heat tinting on the surrounding cheek surfaces, by the microstructural and hardness changes, and the oxide scale observed on the fracture surfaces. The fracture surfaces were significantly damaged after the failure, which removed any possible evidence relating to the origin or mode of failure. The crankshaft

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appeared to have fractured due to torsional fatigue, as evidenced by the alternating 45-degree path of the additional cracking on the fracture samples. A nearby pin and cheek were evaluated as representative samples for conformance of the crankshaft, and no material non-conformances were identified. A representative connecting rod bearing was also evaluated for conformance. All plating layer thicknesses were conforming. The bearing OD overlay was slightly thicker than the requirement but is not a cause for failure. Three of the connecting rods have potentially been replaced in service at some point in time. The root cause of the failure is unknown, but it is not due to material conformance issues.

2.7 Aircraft Engine History

Based on available records, the engine was built new on May 23rd, 1983, and was shipped to AVPIROE. The engine was rebuilt at the Lycoming Engines factory on May 12th, 1992, when it was then sold to SAIR Aviation in Syracuse. The engine has not been returned to the factory since that rebuild. Overhaul records indicate that the crankshaft and connecting rods had undergone magnetic particle inspection on June 03, 2022.

The most recent engine overhaul was done on May 09, 2022, by Pegasus Air Service. At the time of the accident, the engine reportedly had 582 hours since the overhaul. The total engine hours since new is unknown. A Certificate of Release to Service of the Lycoming Engine - Model # O-235.L2C and S/N: RL-23652-15 with status of OVERHAULED certified by Pegasus Air Services Inc. was issued last May 09, 2022. A Certificate of conformance for quality for Quality Assurance of the Aircraft Engine was also issued by same maintenance company last June 14, 2023.

In reference with the documents gathered on the engine overhauling records, it revealed that the engine with S/N: RL-23652-15 was originally installed and pulled out from RP-C 8845 aircraft last November 25, 2021 due to propeller strike to a portable ladder. The crankshaft of the engine was tagged by the operator as reparable and subject for NDT before sending it to Pegasus Air Services Inc. Review of available records on the work done by Pegasus Air Services Inc. revealed that the engine overhaul started April 26, 2022. The crankcase was found to have crack and was replaced by a new one. All other engine replacement parts were provided by the operator during the overhaul. It further revealed the crankshaft was not replaced and a magnetic particle inspection was performed in accordance with ASTM E144/E144M-16E1DT. During the said inspection, there was no indication of cracks and it passed the satisfactory inspection last June 03, 2022. However, there was no records showing that the crankshaft was subjected for further extensive inspection during the overhaul.

In view with the above information particularly on the lack of supporting documents to prove that the crankshaft undergoes further extensive inspection during the overhaul and the noted failure in the aircraft engine during the teardown inspection, it can be said that the likelihood of this loss of power being associated with the propeller strike accident last November 25, 2021 is noteworthy. The sudden stoppage of the propeller during the

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propeller strike might have potentially caused severe loading on the crankshaft. The initial damage it might have incurred last 2021 may have allow it to safely operate for some time, but the progression of the problems may have become significantly severe with time and wear. Based on research and write-ups related to this kind of occurrence, propeller strikes range from nearly no engine damage to catastrophic failures.

2.8 FAA Advisory Circular/Lycoming Mandatory Service Bulletin

On March 3, 1978, an Advisory Circular (AC No. 20-103) was issued by the Department of Transportation of the Unites States of America (Appendix "A") to provide information and suggest procedures to increase crankshaft service life and to minimize crankshaft failures. Available records available to the operator does not show the awareness of the said FAA advisory circular. In the said document, the four (4) possible reasons attributed to crankshaft failures are enumerated below:

- **a.** Material defects, which are few in number.
- **b.** Manufacturing defects that are minimal due to the application of quarterly control and inspection procedures employed by the manufacturers.
- **c.** Overheating caused by improper operating/ maintenance techniques.
- **d.** Overstress due to improper operating techniques, out of balance condition. or undetected damage following an accident or incident.

Items a and b are uncontrollable factors for the operators and maintenance personnel; however, items c and d can be addressed when attention to engine operation and maintenance techniques are properly observed.

The advisory enumerated several recommendations to avoid engine and crankshaft damage. The following are deemed highly relevant in this report.

- **a.** The adherence to manufacturer's operating instructions to avoid crankshaft damage.
- **b.** Follow manufacturer's recommendations for changing oil.
- **c.** The removal of nitride layer during overhaul or repair of a crankshaft can result in a stress riser and eventual crankshaft failure. Particular attention should be given to the grinding limits recommended by the engine manufacturer.

On October 18, 2016, a mandatory service bulletin No, 533C was issued by Lycoming engine on the recommended actions for sudden engine stoppage, propeller/rotor strike or loss of propeller/rotor blade or tip (Appendix 2). This mandatory service bulletin provides the sequential task during the examination of the crankshaft. Except for the

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magnetic particle inspection, there are however no available records that shows the sequential task performed on the crankshaft during the overhaul of the engine last April 26, 2022.

3. CONCLUSIONS

3.1 Findings

a. The Pilot was trained and qualified on the Textron Aviation Inc., Cessna C-152 aircraft.

b. The Pilot has a valid license and medical certificate issued by the Licensing and Certification Division (LCD) and Office of Flight Surgeon and Aviation Medicine (OFSAM), CAAP respectively.

c. Visual meteorological condition prevailed at the time of the occurrence.

d. The aircraft was properly released for flight on the day of the occurrence.

e. The aircraft has a current Certificates of Airworthiness and Registration.

f. The aircraft engine was overhauled by Pegasus Air Services Inc. on May 09, 2022.

g. All engine replacement parts were provided by OMNI Aviation Corporation.

h. The broken crankshaft was sent to Lycoming Engines Factory for failure analysis.

i. The crankshaft was originally installed from the engine with S/N: L-24222-15.

j. The crankshaft was pulled out last November 25, 2021 due to propeller strike to a portable ladder.

k. A magnetic particle inspection was performed on the crankshaft in accordance with ASTM E144/E144M-16E1DT.

l. During the inspection of the crankshaft, there was no indication of cracks.

m. There were no records showing that the crankshaft undergoes further extensive inspection during the overhaul.

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3.2 Cause Factor

3.2.1 Primary Cause Factor

a. The failure of the engine crankshaft that resulted in the total loss of power.

3.2.2 Contributory Cause Factor

a. Non-adherence to FAA Advisory Circular No. 20-103.

b. Non-adherence to Lycoming Mandatory Service Bulletin. No. 533C.

4. SAFETY ACTIONS

4.1 As a result of the accident, OMNI Aviation Corporation initiated safety corrective actions to mitigate the probability of the accident:

a. In accordance with the Service Instruction regarding engine overhauling:

1. Strict monitoring of engine history before endorsement to MRO.
2. Proper identification and tagging of major engine parts prior to overhauling.

b. Recertification of all engine overhauled by the same center- Pegasus Air Services.

c. Condemnation of aircraft engines or parts with major damage (e.g., propeller strikes).

d. Strict monitoring of life-limited engine components.

e. Avoidance and prevention of cannibalization and swapping of engine parts.

-----END-----

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AC NO: 20-103
DATE: 3/7/78

ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: AIRCRAFT ENGINE CRANKSHAFT FAILURE

1. PURPOSE. This advisory circular provides information and suggests procedures to increase crankshaft service life and to minimize crankshaft failures.

2. GENERAL.

a. Although a high level of safety is provided in the design of engine crankshafts, failures do occur. Reports indicate that crankshaft failures can be attributed to:

(1) Material defects, which are few in number.

(2) Manufacturing defects that are minimal due to the application of quality control and inspection procedures employed by the manufacturers.

(3) Overheating caused by improper operating/maintenance techniques.

(4) Overstress due to improper operating techniques, out of balance condition, or undetected damage following an accident or incident.

b. Aircraft owners/operators and maintenance personnel have no control over material or manufacturing defects that cause crankshaft failures. However, with proper attention to engine operation and maintenance techniques, crankshaft failures related to overheating and overstress can be reduced.

3. OVERHEATING.

a. The following may cause crankshaft damage due to overheating:

(1) Bearing spin causes heat and refers to a connecting rod or crankshaft main bearing rotating in its mounting. Crankshaft damage is usually due to oil starvation.

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(2) Fillet ride creates heat and refers to a condition where the crankshaft rides a curved fillet area on a connecting rod, thrust, or main bearing. The condition occurs without presence of an oil film, and excessive heat is generated in a local area of the crankshaft. The condition usually develops from wear on engine parts.

(3) Engine oil overtemperature may result in improper lubrication by thinning of the oil. Improper operating techniques are most often the cause of oil overtemperature.

(4) Contaminated oil resulting in improper lubrication or oil starvation.

(5) Improper engine pre-oiling when new, overhauled, or after a long shutdown period.

(6) Overboost of supercharged engines contributes to overheating as well as overstress of parts.

b. Repair following any of those conditions should include inspection and consideration of crankshaft damage which could lead to complete crankshaft failure.

4. OVERSTRESS. Crankshafts are very susceptible to overstress. The original design of the crankshaft provides for normal loads; however, if additional vibratory stress or increased force are imposed, structural failure can be induced. Common causes of structural overload are:

a. A propeller out-of-balance or out-of-track condition.

b. A propeller strike resulting in sudden stoppage.

c. A liquid-lock that occurs when the combustion chamber is filled with fuel or oil and is usually encountered at initial start-up and is caused by overpriming or oil filling the cylinders during long periods of engine shutdown. As a result of liquid-lock, the piston, connecting rod, cylinder, and crankshaft suffer very high stress if any attempt is made to operate the engine.

d. A detuning of counterweights on balance weight-equipped crankshafts is a source of overstress for the crankshaft. Many engines are fitted with balance weights mounted on pins running in precision ground bushings as an integral part of the crankshaft. The counterweights are designed to position themselves by the inertia forces generated during crankshaft rotation and effectively absorb and dampen crankshaft vibration. If the counterweights are detuned (allowed to slam on mounts), the vibrations are not properly dampened and crankshaft failure can occur. Counterweight detuning can occur from rapid opening and closing of the throttle, excessive speed, excessive

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power, operating at high engine speed and low manifold pressure, and improper feathering procedures.

e. Overboost of supercharged engines applies high stress to the crankshaft.

f. Accident/incident damage. Special consideration should be given to crankshaft damage, if a propeller strike, severe vibration, or impact damage is involved.

g. Detonation or pre-ignition caused by improper fuel leaning procedures, excessive cylinder head temperatures, or improper ignition.

h. Operation at critical vibration conditions that may occur during a one cylinder-out situation or a restricted speed range.

5. RECOMMENDATIONS.

a. Operating procedures. Adhere to manufacturer's operating instructions and avoid overheating, detuning, liquid-lock, and overboost. Observe engine speed and power output limitations. Observe any special placards to avoid critical RPM.

b. Maintenance procedures.

(1) Maintenance personnel should consider crankshaft damage if a propeller strike, sudden stoppage, or liquid-lock occurs. Crankshaft damage should also be considered when repairing piston or connecting rod failure, gear train failure, loss of oil pressure, and other engine malfunctions and problems. Frequent checks of propeller track and balance will reduce undesired vibratory stress. Concern for proper quantity and quality of oil will aid in reducing friction heat. Proper rigging and operation of oil cooler and cowl flaps will reduce heating problems.

(2) The engine's worst enemy is contaminated oil that eventually clogs the engine oil passages resulting in oil starvation that starts the deteriorations of parts, creating overheating and crankshaft distress. Follow the manufacturer's recommendations for changing the oil. Keeping the engine oil clean will help increase engine life and reliability.

(3) Before starting an engine that is new, overhauled, or has been shutdown for a long period of time, particular attention should be given to pre-oiling, especially during cold weather. The pre-oiling procedure recommended by the engine manufacturer should be followed to preclude the operation of an engine without sufficient lubrication.

(4) Most crankshafts are nitrided to increase the bearing journal surface hardness. The removal of nitride during overhaul or repair of a crankshaft can result in a stress riser and eventual crankshaft failure.

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Accordingly, particular attention should be given to the grinding limits recommended by the engine manufacturer.

(5) Present day aircraft engines designed with higher cylinder pressures for increased efficiency and horsepower require greater accuracy in ignition timing. Improper engine performance, burned pistons, failures of engine crankshafts, and engine failures have been traced directly to improperly timed ignition and inadequate ignition system inspection. The degree of accuracy necessary to correctly time the ignition can be obtained by following the recommended procedures provided by the manufacturer for each engine model.

(6) When an engine experiences an overspeed, an overboost, or a connecting rod failure, the crankshaft is subjected to abnormal stress levels. A detailed inspection may be necessary to locate possible crankshaft distress. The inspection should be accomplished in accordance with the engine manufacturer's recommendations.

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MANDATORY SERVICE BULLETIN

DATE:	October 18, 2016	Service Bulletin No. 533C (Supersedes Service Bulletin No. 533B) Engineering Aspects are FAA Approved

SUBJECT:	Recommended Action for Sudden Engine Stoppage, Propeller/Rotor Strike or Loss of Propeller/Rotor Blade or Tip
MODELS AFFECTED:	All Lycoming reciprocating aircraft engines
TIME OF COMPLIANCE:	BEFORE FURTHER FLIGHT
REASON FOR REVISION	Applies to all Lycoming aircraft engines (not just direct drive engines); added checklist specific for Lycoming geared engines; updated checklist which applies to all other Lycoming aircraft engines, added check for connecting rod squareness to the checklists.

NOTICE: Incomplete review of all the information in this document can cause errors. Read the entire Service Bulletin to make sure you have a complete understanding of the requirements.

This Service Bulletin identifies propeller/rotor damage conditions and gives corrective action recommendations for aircraft engines that have had propeller /rotor damage as well as any of the following:

- Separation of the propeller/rotor blade from the hub
- Loss of a propeller or rotor blade tip
- Sudden stoppage

A propeller strike includes:

- Any incident, whether or not the engine is operating, where repair of the propeller is necessary
- Any incident during engine operation where the propeller has impact on a solid object. This incident includes propeller strikes against the ground. Although the propeller can continue to turn, damage to the engine can occur, possibly with progression to engine failure
- Sudden RPM drop on impact to water, tall grass, or similar yielding medium where propeller damage does not usually occur

A propeller strike can occur at taxi speeds and during touch-and-go operations with propeller tip ground contact. In addition, propeller strikes also include situations where an aircraft is stationary and a landing gear collapse occurs causing one or more blades to be bent, or where a hangar door (or other object) hits the propeller blade. These instances are cases of sudden engine stoppage because of potentially severe side loading on the crankshaft propeller flange, front bearing, and seal.

⚠ CAUTION: BASED UPON THE ACCUMULATED ENGINEERING, TECHNICAL, AND HISTORICAL DATA AVAILABLE, LYCOMING ENGINES **PROHIBITS** STRAIGHTENING OR GRINDING OF BENT CRANKSHAFT PROPELLER FLANGES TO RESTORE MAXIMUM RUN-OUT SPECIFICATION AS NOTED IN THE LATEST REVISION OF THE SERVICE TABLE OF LIMITS - SSP-1776. IF THE CRANKSHAFT PROPELLER FLANGE IS BENT, REPLACE THE CRANKSHAFT. **DO NOT TRY TO STRAIGHTEN OR GRIND THE CRANKSHAFT PROPELLER FLANGE.**

Recommended Corrective Action for Propeller Strikes

⚠ CAUTION: DAMAGE TO A PROPELLER IS SERIOUS AND CAN CAUSE THE ENGINE TO BE UNAIRWORTHY.

Circumstances of a propeller strike cannot always be used as predictors for the extent of engine damage or its future reliability. There can be varying degrees of damage to an engine and propeller from a propeller strike. The initial damage can be hidden but could become progressively worse with time and wear.

Given these possibilities and the fact that there is no identified clear, quantifiable threshold limit or gradient standard to reliably measure the extent of damage to an engine, Lycoming Engines can only recommend BEFORE FURTHER FLIGHT, that you complete the tasks in the sequential order shown in the applicable "Inspection Checklist After a Propeller Strike" included in this Service Bulletin as the corrective action for a propeller strike. One checklist applies specifically to Lycoming geared engines (GO-435, GO-480, GSO-480, IGO-480, IGO-540, IGSO-540, and TIGO-541) while the other checklist is for all other Lycoming aircraft engines. Make a copy of the checklist that applies to your engine model, complete it and keep it as a service record. Record all results and any corrective action taken in compliance as per the revision of this Service Bulletin in the engine logbook.

NOTICE: The agency that returns the aircraft to service is responsible for the decision to operate an engine that had a propeller strike. Lycoming Engines does not take the responsibility for the decision to return the engine to service after a propeller strike.

Engine Inspection Checklist After Propeller Strike for All Lycoming Geared Engines			
Engine Model:		**Engine Serial Number:**	
Date Inspection Started:		**Date Inspection Completed:**	
Sequential Task		**Additional Information**	**Corrective Action Done/Comments**
1.	Examine the propeller for extent of damage; record condition of propeller.	Condition of Propeller/Corrective Action: ☐Propeller satisfactory ☐Repair propeller in accordance with propeller manufacturer's instructions ☐Replace propeller in accordance with the airframe manufacturer's instructions.	
2.	Remove the propeller.	As per the airframe and propeller manufacturer's instructions.	
3.	Remove the engine.	In accordance with the airframe manufacturer's instructions.	
CRANKCASE P/N:		**MATCH NO:**	
4.	Disassemble the engine - remove the crankshaft, camshaft, connecting rods, crankshaft gear, and internal steel parts.	In accordance with the applicable Lycoming engine manual.	
5.	Complete blast cleaning of the crankcase with 17 grit walnut shells or equivalent at 35 to 45 psi (241 to 310 kPa); remove all coatings on the crankcase and engine mount bosses.	Make sure there is no dirt, debris, sludge, paint, or any other substance that could prevent reliable Fluorescent Penetrant Inspection (FPI) or subsequent oil flow.	
6.	Complete blast cleaning of the oil sump and engine mount bosses with 17 grit walnut shells or equivalent at 35 to 45 psi (241 to 310 kPa).	Make sure there is no dirt, debris, sludge, paint, or any other substance that could prevent reliable FPI or subsequent oil flow.	
7.	Complete blast cleaning of the engine mount brackets (on six-cylinder engines) and, if used, the lower mount rings (on helicopter engines) with 17 grit walnut shells or equivalent at 35 to 45 psi (241 to 310 kPa).	Make sure there is no dirt, debris, sludge, paint, or any other substance that could prevent reliable FPI or subsequent oil flow.	
8.	Complete blast cleaning of the accessory housing with 17 grit walnut shells or equivalent at 35 to 45 psi (241 to 310 kPa).	Make sure there is no dirt, debris, sludge, paint, or any other substance that could prevent reliable FPI or subsequent oil flow.	

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Engine Inspection Checklist After Propeller Strike for All Lycoming Geared Engines (Cont.)			
Sequential Task		**Additional Information**	**Corrective Action Done/Comments**
9.	Remove and discard the existing crankshaft gear retaining bolt and lockplate.		
10.	Examine the crankshaft.	Refer to the applicable Lycoming engine manual and the latest revision of the Service Table of Limits - SSP-1776 for the crankshaft disassembly and inspection procedures.	
11.	Examine, the crankshaft counter-bored recess, the alignment dowel especially at the base where it goes into the crankshaft, the bolt hole threads, and the crankshaft gear for wear, galling, corrosion, and fretting.	Refer to the latest revision of Service Bulletin No. SB-475. If the bolt hole threads are damaged, they cannot be repaired. Replace the crankshaft.	
12.	Clean the crankshaft, camshaft, crankshaft gear, counterweights, rollers and bushings.	Make sure there is no dirt, debris, sludge, paint, or any other substance that could prevent reliable magnetic particle inspection or subsequent oil flow.	
13.	Clean the following internal parts made of steel: • Connecting rods • Tappets and lifters • Piston pins • Rocker shafts • Accessory drive gears • Magneto drive gears • Idler and oil pump shafts • Shaft gears and impellers		

⚠ **CAUTION:** BASED UPON THE ACCUMULATED ENGINEERING, TECHNICAL, AND HISTORICAL DATA AVAILABLE, LYCOMING ENGINES PROHIBITS STRAIGHTENING OR GRINDING OF BENT CRANKSHAFT PROPELLER FLANGES TO RESTORE MAXIMUM RUN-OUT SPECIFICATION AS NOTED IN THE LATEST REVISION OF THE SERVICE TABLE OF LIMITS - SSP-1776. IF THE CRANKSHAFT PROPELLER FLANGE IS BENT, REPLACE THE CRANKSHAFT. DO NOT TRY TO STRAIGHTEN OR GRIND THE CRANKSHAFT PROPELLER FLANGE.

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Engine Inspection Checklist After Propeller Strike for All Lycoming Geared Engines (Cont.)			
CRANKSHAFT P/N:		**S/N:**	
Sequential Task		**Additional Information**	**Corrective Action Done/Comments**
14.	Measure the flange run-out on the crankshaft.	Refer to the latest revisions of both Service Bulletin No. SB-240 and the Service Table of Limits - SSP-1776 for crankshaft flange run-out tolerance. Record the crankshaft flange run-out measurement.*	☐Use crankshaft ☐Replace cranksha
15.	Measure the main bearing run-out on the crankshaft.	Refer to the latest revision of the Service Table of Limits - SSP-1776 for the main bearing run-out tolerance Record the main bearing run-out measurement.*	☐Use crankshaft ☐Replace cranksha
16.	Measure the polished dimensions on the main journals.	Refer to the latest revision of the Service Table of Limits - SSP-1776 for the dimensions on the main journals Record the dimensions of the main journals.*	☐Main journals within acceptable limits - use crankshaft ☐Replace crankshat
17.	Measure the polished dimensions on the pin journals.	Refer to the latest revision of the Service Table of Limits - SSP-1776 for the dimensions on the pin journals. Record the dimensions of the pin journals.*	☐Pin journals within acceptable limits - use crankshaft ☐Replace crankshat

* If the measurement or dimension is out of tolerance, discard the crankshaft and replace it with a serviceable crankshaft. Install the crankshaft per the applicable Lycoming manual and the latest revision of the Service Table of Limits - SSP-1776.

			Parallelism Measurement	
18.	Complete a check of connecting rod parallelism.	Refer to the section "Connecting Rod Parallelism/Squareness Check" in this Service Bulletin. Record the parallelism measurement for each connecting rod. Replace all connecting rods not in compliance with measurements in the latest revision of the Service Table of Limits - SSP-1776 (Reference 503).	Connecting Rod 1	
			Connecting Rod 2	
			Connecting Rod 3	
			Connecting Rod 4	
			Connecting Rod 5	
			Connecting Rod 6	
			Connecting Rod 7	
			Connecting Rod 8	

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Engine Inspection Checklist After Propeller Strike for All Lycoming Geared Engines (Cont.)			
Sequential Task		Additional Information	Corrective Action Done/Comments
19.	Complete a check of connecting rod squareness.	Refer to the section "Connecting Rod Parallelism/Squareness Check" in this Service Bulletin. Record the squareness measurement for each connecting rod. Replace all connecting rods not in compliance with measurements in the latest revision of the Service Table of Limits - SSP-1776 (Reference 504).	Squareness Measurement Connecting Rod 1 Connecting Rod 2 Connecting Rod 3 Connecting Rod 4 Connecting Rod 5 Connecting Rod 6 Connecting Rod 7 Connecting Rod 8

NOTICE: The magnetic particle inspection must be done by a certified technician as per the latest revision of Service Instruction No. SI-1285.

20.	Complete a magnetic particle inspection on the crankshaft.	Record test results.	☐ Use crankshaft ☐ Replace crankshaft
21.	Complete a magnetic particle inspection on the crankshaft counterweights. Examine the counterweight bushing bores in both the counterweights and the crankshaft.	Record test results.	Replace all counterweight pins, bushings, end plates and snap rings - regardless of their condition.
22.	Complete a magnetic particle inspection on the camshaft.	Record test results.	☐ Use camshaft ☐ Replace camshaft
23.	Complete a magnetic particle inspection on the connecting rods.	Record test results.	Replace connecting rod bolts and nuts -regardless of condition. Refer to the latest revision of Service Instruction No. SI-1458 for assembly instructions.
24.	Complete a magnetic particle inspection on the crankshaft gear; examine the gear end as per the latest revision of Service Bulletin No. SB-475.	Record test results.	☐ Use crankshaft gear ☐ Replace crankshaft gear
25.	Complete a magnetic particle inspection on the following internal parts made of steel: • Accessory drive gears • Magneto drive gears • Idler and oil pump shafts • Shaft gears and impellers • Piston pins • Connecting rods • Propeller shaft • Stationary gear • Thrust bearing oil slinger • Pinion roller • Pinion gear • Pinion gear drive plate • Pinion cage • Stationary gear drive plate • Supercharger shaft gear (if equipped)	Record test results.	Use Replace ☐ ☐ Accessory drive gears ☐ ☐ Magneto drive gears ☐ ☐ Idler and oil pump shafts ☐ ☐ Shaft gears and impellers ☐ ☐ Piston pins ☐ ☐ Connecting rods ☐ ☐ Propeller shaft ☐ ☐ Stationary gear ☐ ☐ Thrust bearing oil slinger ☐ ☐ Pinion roller ☐ ☐ Pinion gear ☐ ☐ Pinion gear drive plate ☐ ☐ Pinion cage ☐ ☐ Stationary gear drive plate ☐ ☐ Supercharger shaft gear

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Engine Inspection Checklist After Propeller Strike for All Lycoming Geared Engines (Cont.)			
Sequential Task		Additional Information	Corrective Action Done/Comments
26.	Complete the visual inspection and Fluorescent Penetrant Inspection (FPI) on the crankcase. Refer to the latest revision of Service Instruction No. SI-1285. Closely examine the forward crankcase bearing support and adjacent structure.	Record test results.	☐ Use crankcase ☐ Replace crankcase
27.	Complete the visual inspection and FPI on the oil sump.	Record test results.	☐ Use oil sump ☐ Replace oil sump
28.	Complete the visual inspection and FPI on the engine mounts and, if used, the lower mount rings (on helicopter engines).	Record test results.	☐ Use engine mounts ☐ Replace engine mounts
29.	Complete the visual inspection and FPI on the accessory housing.	Record test results.	☐ Use accessory housing ☐ Replace accessory housing
30.	Complete the visual inspection and FPI on the aluminum oil pump impeller.	Record test results.	☐ Use impeller ☐ Replace impeller
NOTICE: Counterweight rollers and bushings must be replaced.			
31.	Complete the visual inspection and FPI on the tappets (not roller tappets) and lifters. Refer to the latest revision of Service Instruction No. SI-1011.	Record test results.	☐ Tappets/lifters acceptable ☐ Replace tappets/lifter
32.	Complete the visual inspection and FPI on the reduction gear housing	Record test results.	☐ Use reduction gear housing ☐ Replace reduction gear housing
33.	Complete the visual inspection and FPI on the supercharger housing (if equipped)	Record test results.	☐ Use supercharger housing ☐ Replace supercharger housing
34.	Complete the visual inspection and FPI on the supercharger impeller	Record test results.	☐ Use supercharger impeller ☐ Replace supercharger impeller
35.	Examine each magneto in accordance with the magneto manufacturer's instructions.	Record test results.	☐ Replace magneto
36.	Examine the pistons as per instructions in the applicable Lycoming manual and the latest revision of the Service Table of Limits - SSP-1776.	Record test results.	☐ Pistons acceptable ☐ Replace pistons

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Engine Inspection Checklist After Propeller Strike for All Lycoming Engines - Except Geared Engines (Cont.)			
Sequential Task		**Additional Information**	**Corrective Action Done/Comments**
36.	Review the documents of all other engine-mounted accessories on the engine, propeller governor (if installed), etc. for instructions on what to do for components exposed to sudden engine stoppage.		
37.	Assemble and install the engine. Install the propeller and test the engine. Complete an operational check of the engine.	In accordance with instructions in the applicable Lycoming engine manuals, the latest revisions of the Service Table of Limits - SSP-1776 and Service Instruction No. SI-1427.	
38.	Record maintenance findings and any corrective action in the engine logbook.		

UNAIRWORTHY PARTS:

ADDITIONAL WORK/INSPECTIONS NECESSARY:

OUTCOME OF INSPECTION- SUMMARY NOTES:

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Engine Inspection Checklist After Propeller Strike for All Lycoming Engines - Except Geared Engines			
Engine Model:		**Engine Serial Number:**	
Date Inspection Started:		**Date Inspection Completed:**	
Sequential Task		**Additional Information**	**Corrective Action Done/Comments**
1.	Examine the propeller for extent of damage; record condition of propeller.	Condition of Propeller/Corrective Action: ☐ Propeller satisfactory ☐ Repair propeller in accordance with propeller manufacturer's instructions ☐ Replace propeller in accordance with the airframe manufacturer's instructions.	
2.	Remove the propeller.	As per the airframe and propeller manufacturer's instructions.	
3.	Remove the engine.	In accordance with the airframe manufacturer's instructions.	
CRANKCASE P/N:		**MATCH NO:**	
4.	Disassemble the engine - remove the crankshaft, camshaft, connecting rods, crankshaft gear, and internal steel parts.	In accordance with the applicable Lycoming engine manual.	
5.	Complete blast cleaning of the crankcase with 17 grit walnut shells or equivalent at 35 to 45 psi (241 to 310 kPa); remove all coatings on the crankcase and engine mount bosses.	Make sure there is no dirt, debris, sludge, paint, or any other substance that could prevent reliable Fluorescent Penetrant Inspection (FPI) or subsequent oil flow.	
6.	Complete blast cleaning of the oil sump and engine mount bosses with 17 grit walnut shells or equivalent at 35 to 45 psi (241 to 310 kPa).	Make sure there is no dirt, debris, sludge, paint, or any other substance that could prevent reliable FPI or subsequent oil flow.	
7.	Complete blast cleaning of the engine mount brackets (on six-cylinder engines) and, if used, the lower mount rings (on helicopter engines) with 17 grit walnut shells or equivalent at 35 to 45 psi (241 to 310 kPa).	Make sure there is no dirt, debris, sludge, paint, or any other substance that could prevent reliable FPI or subsequent oil flow.	
8.	Complete blast cleaning of the accessory housing with 17 grit walnut shells or equivalent at 35 to 45 psi (241 to 310 kPa).	Make sure there is no dirt, debris, sludge, paint, or any other substance that could prevent reliable FPI or subsequent oil flow.	

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Engine Inspection Checklist After Propeller Strike for All Lycoming Engines - Except Geared Engines (Cont.)			
	Sequential Task	**Additional Information**	**Corrective Action Done/Comments**
9.	Remove and discard the existing crankshaft gear retaining bolt and lockplate.		
10.	Examine the crankshaft.	Refer to the applicable Lycoming engine manual and the latest revision of the Service Table of Limits - SSP-1776 for the crankshaft disassembly and inspection procedures.	
11.	Examine, the crankshaft counter-bored recess, the alignment dowel especially at the base where it goes into the crankshaft, the bolt hole threads, and the crankshaft gear for wear, galling, corrosion, and fretting.	Refer to the latest revision of Service Bulletin No. SB-475. If the bolt hole threads are damaged, they cannot be repaired. Replace the crankshaft.	
12.	Clean the crankshaft, camshaft, crankshaft gear, counterweights, rollers and bushings.	Make sure there is no dirt, debris, sludge, paint, or any other substance that could prevent reliable magnetic particle inspection or subsequent oil flow.	
13.	Clean the following internal parts made of steel: • Connecting rods • Tappets (not roller tappets) • Piston pins • Rocker shafts • Accessory drive gears • Magneto drive gears • Idler and oil pump shafts • Shaft gears and impellers		

⚠ **CAUTION:** BASED UPON THE ACCUMULATED ENGINEERING, TECHNICAL, AND HISTORICAL DATA AVAILABLE, LYCOMING ENGINES PROHIBITS STRAIGHTENING OR GRINDING OF BENT CRANKSHAFT PROPELLER FLANGES TO RESTORE MAXIMUM RUN-OUT SPECIFICATION AS NOTED IN THE LATEST REVISION OF THE SERVICE TABLE OF LIMITS - SSP-1776. IF THE CRANKSHAFT PROPELLER FLANGE IS BENT, REPLACE THE CRANKSHAFT. DO NOT TRY TO STRAIGHTEN OR GRIND THE CRANKSHAFT PROPELLER FLANGE.

Engine Inspection Checklist After Propeller Strike for All Lycoming Engines - Except Geared Engines (Cont.)

CRANKSHAFT P/N:		S/N:	
Sequential Task		**Additional Information**	**Corrective Action Done/Comments**
14.	Measure the flange run-out on the crankshaft.	Refer to the latest revisions of both Service Bulletin No. SB-240 and the Service Table of Limits - SSP-1776 for crankshaft flange run-out tolerance. Record the crankshaft flange run-out measurement.*	☐Use crankshaft ☐Replace cranksha
15.	Measure the main bearing run-out on the crankshaft.	Refer to the latest revision of the Service Table of Limits - SSP-1776 for the main bearing run-out tolerance Record the main bearing run-out measurement.*	☐Use crankshaft ☐Replace cranksha
16.	Measure the polished dimensions on the main journals.	Refer to the latest revision of the Service Table of Limits - SSP-1776 for the dimensions on the main journals Record the dimensions of the main journals.*	☐Main journals within acceptable limits - use crankshaft ☐Replace crankshaf
17.	Measure the polished dimensions on the pin journals.	Refer to the latest revision of the Service Table of Limits - SSP-1776 for the dimensions on the pin journals Record the dimensions of the pin journals.*	☐Pin journals within acceptable limits - use crankshaft ☐Replace crankshaf

* If the measurement or dimension is out of tolerance, discard the crankshaft and replace it with a serviceable crankshaft. Install the crankshaft per the applicable Lycoming manual and the latest revision of the Service Table of Limits - SSP-1776.

			Parallelism Measurement	
18.	Complete a check of connecting rod parallelism.	Refer to the section "Connecting Rod Parallelism/Squareness Check" in this Service Bulletin. Record the parallelism measurement for each connecting rod. Replace all connecting rods not in compliance with measurements in the latest revision of the Service Table of Limits - SSP-1776 (Reference 503).	Connecting Rod 1	
			Connecting Rod 2	
			Connecting Rod 3	
			Connecting Rod 4	
			Connecting Rod 5	
			Connecting Rod 6	
			Connecting Rod 7	
			Connecting Rod 8	

Engine Inspection Checklist After Propeller Strike for All Lycoming Engines - Except Geared Engines (Cont.)

	Sequential Task	Additional Information	Corrective Action Done/Comments	
19.	Complete a check of connecting rod squareness.	Refer to the section "Connecting Rod Parallelism/Squareness Check" in this Service Bulletin. Record the squareness measurement for each connecting rod. Replace all connecting rods not in compliance with measurements in the latest revision of the Service Table of Limits - SSP-1776 (Reference 504).	Squareness Measurement	
			Connecting Rod 1	
			Connecting Rod 2	
			Connecting Rod 3	
			Connecting Rod 4	
			Connecting Rod 5	
			Connecting Rod 6	
			Connecting Rod 7	
			Connecting Rod 8	

NOTICE: The magnetic particle inspection must be done by a certified technician as per the latest revision of Service Instruction No. SI-1285.

20.	Complete a magnetic particle inspection on the crankshaft.	Record test results.	☐ Use crankshaft ☐ Replace crankshaft
21.	Complete a magnetic particle inspection on the crankshaft counterweights. Examine the counterweight bushing bores in both the counterweights and the crankshaft.	Record test results.	Replace all counterweight pins, bushings, end plates and snap rings - regardless of their condition.
22.	Complete a magnetic particle inspection on the camshaft.	Record test results.	☐ Use camshaft ☐ Replace camshaft
23.	Complete a magnetic particle inspection on the connecting rods.	Record test results.	Replace connecting rod bolts and nuts -regardless of condition. Refer to the latest revision of Service Instruction No. SI-1458 for assembly instructions.
24.	Complete a magnetic particle inspection on the crankshaft gear; examine the gear end as per the latest revision of Service Bulletin No. SB-475.	Record test results.	☐ Use crankshaft gear ☐ Replace crankshaft gear
25.	Complete a magnetic particle inspection on the following internal parts made of steel: • Accessory drive gears • Magneto drive gears • Idler and oil pump shafts • Shaft gears and impellers • Piston pins • Connecting rods	Record test results.	Use Replace ☐ ☐ Accessory drive gears ☐ ☐ Magneto drive gears ☐ ☐ Idler and oil pump shafts ☐ ☐ Shaft gears and impellers ☐ ☐ Piston pins ☐ ☐ Connecting rods

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Connecting Rod Parallelism/Squareness Check

NOTICE: The connecting rod parallelism and squareness gage (Figure 1) is necessary for this check.

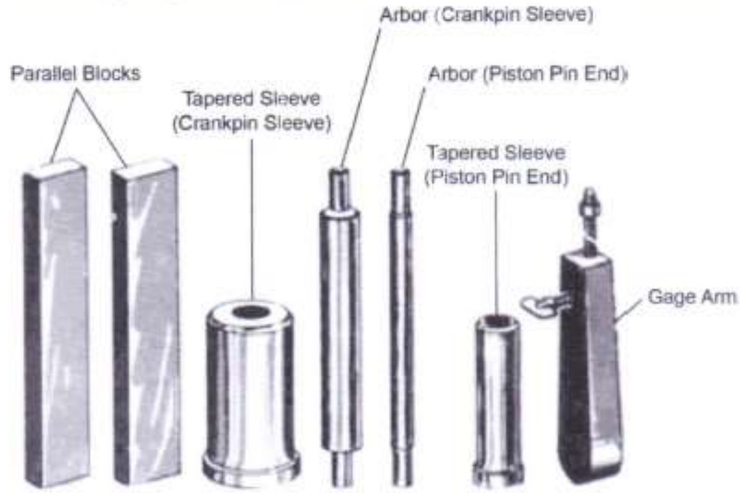

Figure 1
Connecting Rod Parallelism and Squareness Gage

A. Verify that the bearing cap is assembled correctly and is tightened securely.

B. Insert the tapered sleeves (Figure 2) of the Connecting Rod Parallelism and Squareness Gage in the bearing holes in the connecting rod.

C. Pull arbors through the sleeves.

D. Put the gage arm on the arbor.

E. Turn the adjusting screw on the gage arm until it just contacts the arbor.

F. Lock the adjusting screw with the wing nut.

G. Make sure the adjusting screw just contacts the arbor.

H. Remove the gage arm and place it on the other end of the arbor.

I. Measure the distance between arbors. For exact parallelism or alignment, the distances measured on both sides are to be the same. Record the measurement.

J. Remove the gage arm (Figure 2).

K. Keep the sleeves and arbors in place.

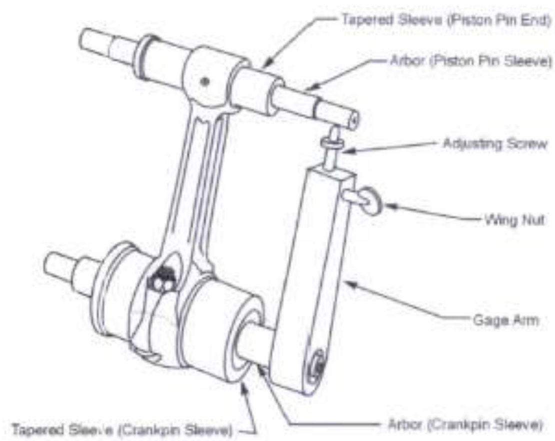

Figure 2
Parallelism Check of Connecting Rods

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L. Put the parallel blocks (Figure 3) of the Connecting Rod Parallelism and Squareness Gage on the surface plate.

M. Put the ends of the arbors on the parallel blocks.

N. For the squareness or twist check, measure clearance at the four check points in Figure 3 where the arbors rest on the parallel blocks using a feeler gage. Record the measurement.

O. Compare the clearance between each arbor and the parallel blocks against the values in the latest revision of the Service Table of Limits - SSP-1776. If out of tolerance, replace the connecting rods and examine the crankshaft to make sure the crankshaft is not damaged.

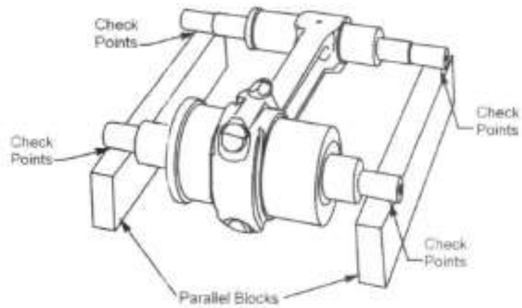

Figure 3
Squareness Check of Connecting Rods

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Engine Inspection Checklist After Propeller Strike for All Lycoming Engines - Except Geared Engines (Cont.)			
Sequential Task		**Additional Information**	**Corrective Action Done/Comments**
26.	Complete the visual inspection and Fluorescent Penetrant Inspection (FPI) on the crankcase. Refer to the latest revision of Service Instruction No. SI-1285. Closely examine the forward crankcase bearing support and adjacent structure.	Record test results.	☐ Use crankcase ☐ Replace crankcase
27.	Complete the visual inspection and FPI on the oil sump.	Record test results.	☐ Use oil sump ☐ Replace oil sump
28.	Complete the visual inspection and FPI on the engine mounts and, if used, the lower mount rings (on helicopter engines).	Record test results.	☐ Use engine mounts ☐ Replace engine mounts
29.	Complete the visual inspection and FPI on the accessory housing.	Record test results.	☐ Use accessory housing ☐ Replace accessory housing
30.	Complete the visual inspection on the oil pump impeller.	Record test results.	☐ Use impeller ☐ Replace impeller
NOTICE: Roller tappets, counterweight rollers, and bushings must be replaced.			
31.	Complete the visual inspection and FPI on the tappets (not roller tappets) and lifters. Refer to the latest revision of Service Instruction No. SI-1011.	Record test results.	☐ Tappets/lifters acceptable ☐ Replace tappets/lifters
32.	Examine each magneto in accordance with the magneto manufacturer's instructions.	Record test results.	☐ Replace magneto
33.	Examine the pistons as per instructions in the applicable Lycoming manual and the latest revision of the Service Table of Limits - SSP-1776.	Record test results.	☐ Pistons acceptable ☐ Replace pistons
34.	Refer to the latest revision of Service Bulletin No. SB-240 to identify any parts that must be replaced during engine assembly.	Record parts that must be replaced.	
35.	Install a new crankshaft gear retaining bolt and lockplate.	Refer to the latest revision of Service Bulletin No. SB-475.	

Engine Inspection Checklist After Propeller Strike for All Lycoming Geared Engines (Cont.)			
Sequential Task		Additional Information	Corrective Action Done/Comments
37.	Refer to the latest revision of Service Bulletin No. SB-240 to identify any parts that must be replaced during engine assembly.	Record parts that must be replaced.	
38.	Install a new crankshaft gear retaining bolt and lockplate.	Refer to the latest revision of Service Bulletin No. SB-475.	
39.	Review the documents of all other engine-mounted accessories on the engine, propeller governor (if installed), etc. for instructions on what to do for components exposed to sudden engine stoppage.		
40.	Assemble and install the engine. Install the propeller and test the engine. Complete an operational check of the engine.	In accordance with instructions in the applicable Lycoming engine manuals, the latest revisions of the Service Table of Limits - SSP-1776 and Service Instruction No. SI-1427.	
41.	Record maintenance findings and any corrective action in the engine logbook.		

UNAIRWORTHY PARTS:

ADDITIONAL WORK/INSPECTIONS NECESSARY:

OUTCOME OF INSPECTION- SUMMARY NOTES:

ISSUED			REVISED			PAGE NO.	REVISION	
MO	DAY	YEAR	MO	DAY	YEAR	14 of 16	C	S.B. 533
06	29	98	10	18	16			

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